Selecting Industrial Magnifiers . . . 2076

INSTRUMENTS and AUTOMATION

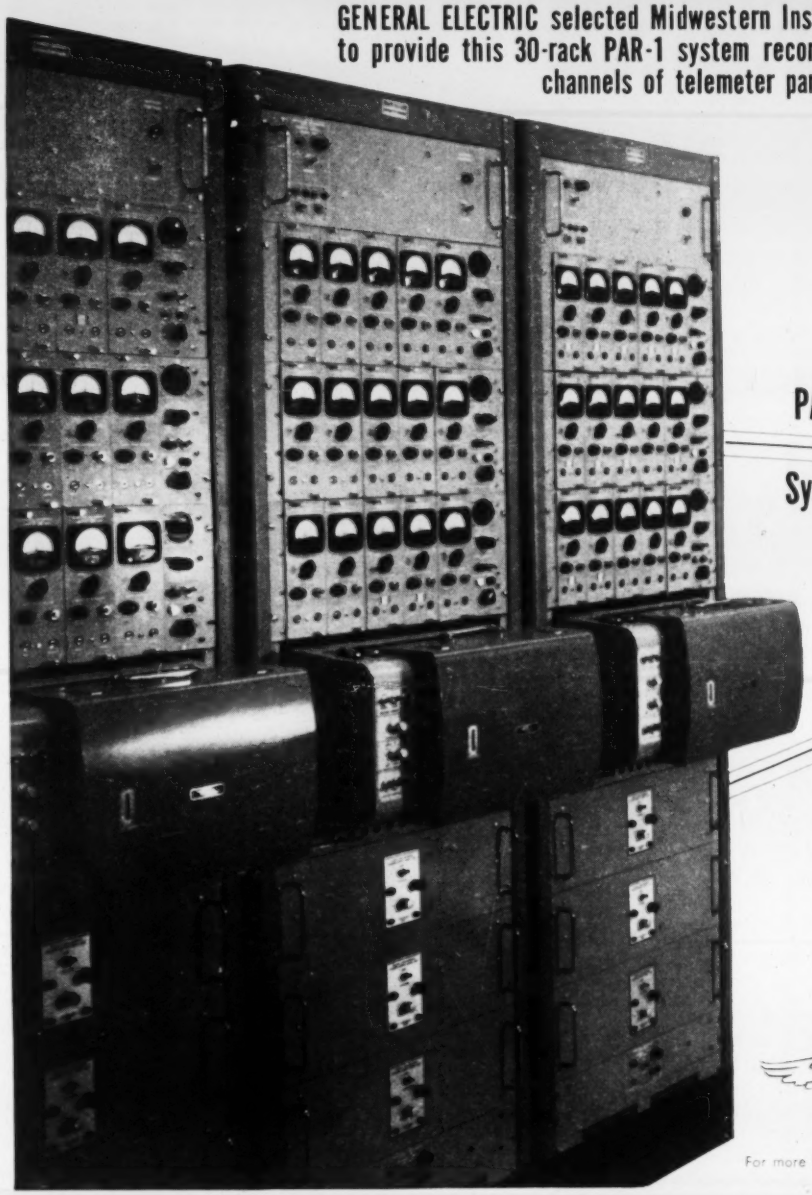
NOVEMBER 1957

Including: Instrument Manufacturing
The Journal of the SCMA
Simulation Council Newsletter

Standards Laboratory Equipment . . . 2066

Precision Analog Recording System . . .

GENERAL ELECTRIC selected Midwestern Instruments to provide this 30-rack PAR-1 system recording 450 channels of telemeter parameters:

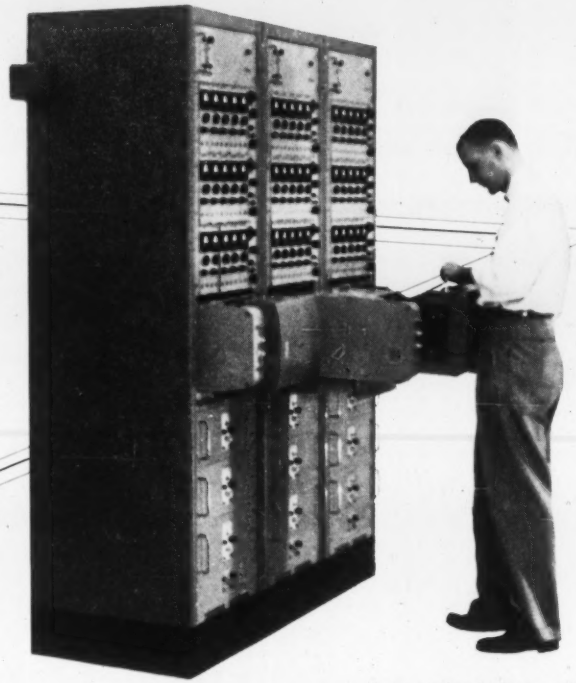


This newest Precision Analog Recording System was designed and perfected by **MI** to provide an extremely accurate method of obtaining an oscillographic record of analog parameters obtained from objects under study. The exceptionally stable amplifiers are of modular construction and are directly interchangeable.

The PAR System also provides a precise method of operating on the input signals which can be scaled and positioned between grid lines on the oscillograph record to have a direct relation to the original physical stimulus thus permitting easier data reduction. This operation on the input signals can be accomplished manually or it may be programmed by punched tape.

PAR-1

System



Features:

15 Amplifier Channels.

Magnetic modulator.

Oscillograph interchangeable Model 591 or Model 602.

Amplifier characteristics:
- Input impedence 100,000 ohms
- Frequency Response:
  - Model 477 DC-300 cps
  - Model 478 DC-3000 cps
- Output power Model 477 Sufficient to deflect a MI 102-500 Galvanometer ± 2 inches
- Model 478 Sufficient to deflect a MI 102-3500 Galvanometer ± 2 inches
- Linearity 0.25%
- Input signal range 0.5 - 50 volts
- Drift and Gain stability: The sum of the drift and gain does not exceed ± 0.5% over the entire input signal range.

Scale Factor — Zero Offset Model 479 Manual or Programmed Adjustment in 256 equal steps.

If your problem is the presentation of Analog Data to a precision degree, with greater flexibility than previously possible, it will be worth your time to investigate **MIDWESTERN INSTRUMENTS PAR-1 SYSTEM.** Let **MI** engineers solve your instrumentation problems.

MIDWESTERN

INSTRUMENTS 41st & Sheridan Road Tulsa, Oklahoma

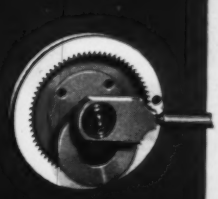
For more information circle 1 on inquiry card.

electro-mechanical computer and control components by Librascope

-DIGITAL CONVERTERS

Most versatile line of shaft position to digital converters models for Gray, Binary, and Binary Coded Decimal Systems. Special models for sine-cosine read-out. Used in digital airborne controls, machine tool controls, or wherever position data must be translated into digital form.

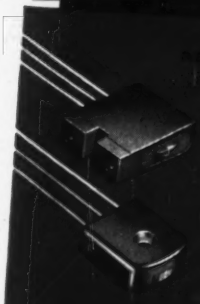
Ask for Catalog No. E10-1



SINE MECHANISM

Provides for instantaneous solution of problems involving the sine or cosine of an angular variable. Angular rotation is converted into a displacement proportional to sine or cosine of the input. Compact, simple, self-contained design.

Ask for Catalog No. 304062



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A complete line of Read-Record Heads for all types of magnetic drum memory systems. Simplicity of design, flexibility of operation, high reading signal and low current are basic characteristics of these read-record heads which are used where reliable performance is essential.

Ask for latest Catalog

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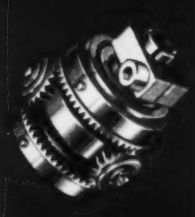
A precision integrating mechanism for totalizing, rate determination, and differential analyzing. Can also be used as a closed loop servo-element for accurate variable speed drive. Small in size, rugged construction for long life; extreme precision.

Ask for Catalog No. 304061



SHAFT DIFFERENTIAL

Four models of precision differentials for application to problems of angular sums, angular velocity sums or sequence operations. May be installed or removed without disassembly of unit or differential. High accuracy; unlimited displacement; small radial clearance. A time-tested design.

Ask for latest information

FOR MORE THAN 20 YEARS, Librascope has manufactured mechanical and electrical computers and components for military and commercial purposes.

Librascope products are designed for reliability, long-life, trouble-free performance.

If you have a problem concerning complete computer/control systems, contact Librascope.

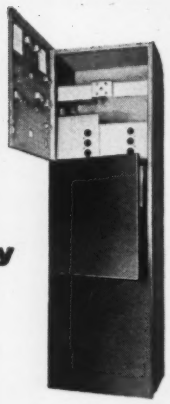
Representatives in principal cities.

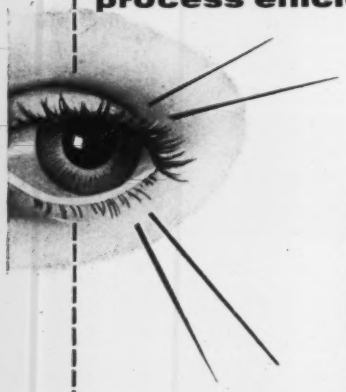
LIBRASCOPE

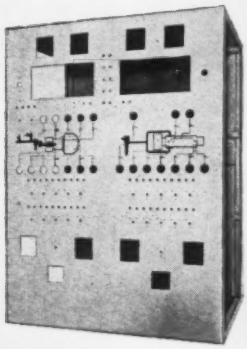
LIBRASCOPE, INC., 808 WESTERN AVE., GLENDALE, CALIFORNIA

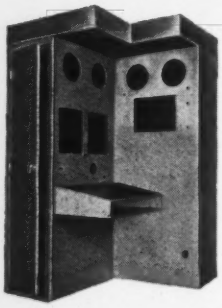
For more information circle **2** on inquiry card.

FALSTROM
"VISIONEERED" panels and control boards help improve process efficiency









Falstrom "visioneered" steel instrument and control boards, graphic panels, consoles, cubicles and cabinets are made exactly to your designs and specifications so as to achieve better functional integration of your instruments, for easier supervision with less fatigue. Falstrom fabrications are made to close tolerances and because of Falstrom's large facilities and modern equipment, no need to sacrifice or compromise on your original specifications and intentions.

Falstrom's "visioneered" construction gives you exactly what you envisage. Put Falstrom "visioneering" to work for you in accurate mountings of any size, in any metal—at low cost.

Write for Falstrom catalog of standard panels and control boards 143A or send prints and requirements for prompt estimate.

FALSTROM

FALSTROM COMPANY
92 Falstrom Court • Passaic, New Jersey

For more information circle **3** on inquiry card.

Don't Worry
about a thing!
The New Sensitive Research CONTACT METER will make it cut a straight line to an accuracy of .25%.

CONTACT MAKING PANEL INSTRUMENTS
for the Automatic Inspection or Control Between Electrical Minimum & Maximum Limits.

Sensitive Research Contact Making Edgewise Panel Instruments provide the means for the electrical sensing of preset values of Voltage, Current, Watts, Micromhos and any other quantity that can be indicated electrically. They are Reference Standards, modified with adjustable contacts and furnished with electronic relay systems. Their proven Stability, Long Life and Traditional Dependability means you ***'DON'T HAVE TO WORRY ABOUT A THING.'***

- **7" or 5" hand-drawn mirrored scale**
- **A.C., D.C. or both**
- **Automatic or manual reset**
- **Accuracies to .25%**
- **Contacts variable over 90% of the instrument's scale**

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Offices in Detroit & Cleveland.

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

SENSITIVE RESEARCH INSTRUMENT CORPORATION

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Symbol of Quality

NEW ROCHELLE, N. Y.

For more information circle **4** on inquiry card.

INSTRUMENTS and AUTOMATION

EDITED FOR USERS OF MEASUREMENT AND CONTROL INSTRUMENTS

Volume 30, No. 11
November 1957

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James Emge
Robert C. Nelson
John H. McLeod, Jr.
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Consulting Editor
Armand T. Gaudreau

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Milo D. Pugh

Production Manager (Editorial, Advertising)
David S. Aland

DISTRICT MANAGERS

Boston 16, Mass., Harold H. Short, Jr., Holt Road, Andover, Mass. Andover 2212

Chicago 1, Ill., Harold W. Haskett, Room 1205, 228 N. La Salle St., Central 6-8963

Cleveland 2, Ohio, William R. Carlson, 8905 Lake Ave.

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Los Angeles 32, Calif., Milo D. Pugh & Associates: M. D. Pugh, P. O. Box 32188, CApitol 2-8857; Hunter Vinton, 1050 Lincoln Ave., Palo Alto Calif., Davenport 5-4815.

New York 17, N. Y., Richard Rimbach, Jr. 525 Lexington Ave., Rm. 359, Murray Hill 8-0980

Philadelphia, Pa., William M. Rees, Jr. 101 N. 33rd St., 509 Wilford Bldg., Evergreen 2-3878

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THE MAGAZINE OF INSTRUMENTATION AND AUTOMATIC CONTROL SINCE JANUARY 1928

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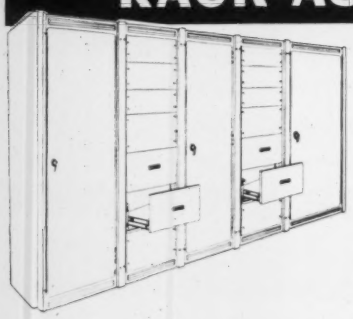
SOLVE THE CABINET HOUSING PROBLEM WITH PAR-METAL UNIVERSAL CABINET RACK ASSEMBLIES



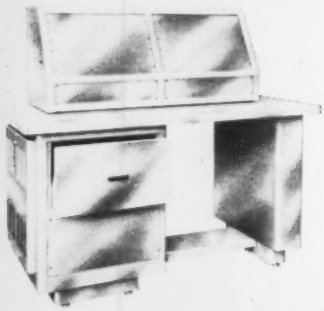
Is it possible to embody "custom-quality" in a standardized unit? *Par-Metal* answers definitely *"yes"*... Indeed, you'll be delighted how easily you can fill your needs with a distinctive Housing from our line of standardized units. And *you'll save money too* — not to mention the time and fuss connected with blueprints when ordering "special" equipment. So give us your problem in metal and enjoy a quick, economical solution.

Only PAR-METAL Universal Cabinet Racks have these adjustable features:

- Solid Sides or Open Sides. Open sides have detachable side panel arrangement. Front Doors are optional equipment.
- Single units, or any arrangement of "multi-racks."
- Vertical Side Supports for adjustable mounting brackets, shelves, and sliding devices.
- Heights: 48⅛", 67⅜", 76⅛", 83⅛".
- Depths: 18", 24". Panel Widths: 19", 24", 30".
- Finishes: Black ripple, grey ripple, primer coat only, grey hammertone enamel, aluminum grey lacquer.

Vertical Side Supports can be used with all our Universal Cabinet Racks. To provide adjustment for mounting brackets, shelves, and sliding devices, holes are drilled and tapped vertically. When installed in *19"* wide racks the clearance between uprights is *17¾"*; in *24"* wide racks clearance is *23¾"*.

A complete line of *standard accessories* such as Roller Trucks, Sliding Shelves, Phono Drawers, Rack Mounting Chasses, Panels, in complete harmony with the proper rack are also available.



UTILITY DESK ASSEMBLIES

These units are admirably suited for control stations, testing apparatus, sound distribution systems, atomic energy installations, etc. They *often eliminate* the need for costly custom-built equipment, as you need only purchase the specific parts you need. The pedestal is *substantially constructed for heavy-duty usage*. Desk Panel Cabinets, Table Tops, Doors, Panels, Pedestals, End Pedestal and Foot Brace, and other parts may be bought as needed.

Cut shows a double unit; also available in single or triple units.

Doors are easily removable, allowing complete access to the *INSIDE FROM ALL SIDES*. Each side is drilled and tapped on "universal" centers so that standard rack panels or doors can be mounted on all sides. Although considerably less in cost than similar "custom-built" units, they are delivered in less time, and avoid the necessity of blueprints, etc.

PAR-METAL ELECTRONIC HOUSINGS

PAR-METAL PRODUCTS CORP.
LONG ISLAND CITY 3, N. Y.
Telephone: AStoria 8-8905

Mail this coupon for information on how PAR-METAL Racks and Utility Assemblies will save you money!

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32-54 49th Street, Long Island City 3, N. Y.

☐ We are interested in "Universal Cabinet" Racks and accessories. ☐ Utility Desk Assemblies.
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Company_____

City_____ State_____ Zone_____

For more information circle **5** on inquiry card.

Letters to the editor

Editor, I&A:

Reading (Mr. Blachman's) article "ACS" in the July issue of *Instruments and Automation*, I have been rather amused by his search for the sex of French computers. I must say his argument is loose and unconvincing.

In the first place, the complete designation of such machines is "machines a calculer." The word "machine" being of the feminine gender, it seems perfectly logical that the shorter name "calculatrice" be feminine also. As a matter of fact the computers of punched-card equipments have always been called "calculatrices."

It is indeed unfortunate that the same word is used for a girl-computer—or should I say computress? But similarly in English a "computer" can be either a machine or a man—or should I have written "computer" for the man and "computor" for the machine?! In French a male computer is a "calculateur" and his female counterpart a "calculatrice."

But if, as is rightly pointed out, the French word for "computer" is still somewhat unsettled, this cannot be generalized and the vast majority of French words and phrases cannot be changed at will. For example, there is only one French equivalent of "double meaning," which is "double entente" and not "double entendre," as printed in the paragraph just preceding this little linguistic crusade.

Col. P. Naslin
Laboratoire Central de L'Armement
Arcueil (Seine), France

To which the author replies:

Thank you for your very enlightening and amusing letter concerning my article in the July issue of *Instruments and Automation*. In reply I can only apologize for the English language, which, according to my dictionary, contains a word *double-entendre*. The dictionary points out that the usual French form is *double entente*, but it does not list it.

Nelson M. Blachman
Mountain View, Calif.

Editor, I&A:

More than 100 years ago (maybe around 1830) a mechanical miracle was the talk of Europe. It was an automatic chess player, apparently a big machine, lots of wheels visible for the curious, playing chess with human partners. I believe that *Scientific American* has published something about this first "automat." . . . It turned out that all the wheels were not operating, that a very small man, hidden in the housing, really played the chess.

The editorial of Mr. Dever, President of Brown Instruments, in the last issue of *I&A* described among real automation the "Office Building in Omaha, Nebraska."

A little man, apparently one Mr. Greer, is sitting at a desk well down in the basement of the office building, in front of a temperature indicator and a switch for 144 rooms, and his job is to operate the switches, read the instrument, and write down the solution in a big log book.

Where is the "automation"? Is automatic temperature control really "automation"?

Dr. George Keinath
Consulting Engineer
Larchmont, N. Y.

The "Office Building in Omaha" is not *complete* automation, with automatic data logging. BUT it is a practical $6000 worth of Automation, and it does the amount of automation that is economically justified for this particular job. Too many persons consider automation as only complete automation (data logging, computing, etc., which costs from $100,000 to $10,000,000). Practical automation means the simplest, most efficient way to perform the job at hand; and the $6000 Omaha Office Building Installation is a good example of basic, practical, everyday, common automation of the type that is *economic for the user and profitable for the supplier* This is the finest type of automation, the type that supports the expensive experiments in computer-controlled data-logged systems that are feasible—but not always economic.

Editor, I&A:

To me and many in my field the total value of your publication depends on your articles on computers and computer usage.

During the last three years at least 25 subscriptions have been sent in on my recommendation due to these articles. About 15 of these I have sent in myself.

RAMBLINGS ON INSTRUMENTATION

Manufacturers' Reps: How they get Human

Try as we might, we couldn't keep a note of quiet pride from sneaking into last month's "Ramblings", which related some eye-opening statistics about the qualifications of our manufacturers' representatives.

The profile of the typical Hays representative drawn by these figures reveals a guy with well above average qualifications in terms of education, experience and professional ability . . . a far cry from the commonly accepted stereotype of the "manufacturers' rep."

Well, while we're proud of the fact that the men who fly our flag are trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean and reverent . . . they do have something else going for them, too.

This "something else" is Industrial Marketing Associates . . . or if you like to save time, simply "IMA". IMA is a congenial group of 10 non-competing manufacturers of allied equipment and 27 country-wide representative organizations banded together in a mutual assistance program designed to help us all be more helpful to customers.

IMA holds Regional Sales Refresher Courses for its members four times a year, each session lasting several days. The curriculum concerns products, installations, service techniques and new ideas.

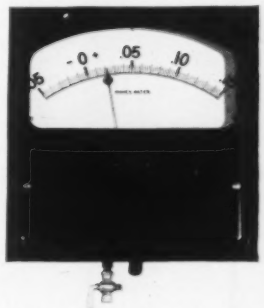
Besides a consistent educational program, IMA members (1) hold regional equipment shows, (2) coordinate exhibits and trade shows, (3) publish a product information magazine with 55,000 circulation (want to get it ? send me your name), (4) exchange information on profit sharing plans, salesmen's remuneration, billing procedures, etc., and (5) occasionally enjoy 19 holes of golf and good fellowship just to keep everything in its proper perspective.

So what ? *You, the customer* profit through being served by a nation-wide group whose local sales engineers can provide you with high caliber technical aid on an entire group of allied equipment.

Be glad to give you the name of your Hays representative!

Some Low-Pressure Sell

Our application engineering department tells us that Hays FOT low pressure direct acting diaphragm type indicators and OT low pressure recorders are being applied to more and more process jobs. Why ? Because (a) the wide selection of ranges we make (0-0.2" water minimum to 0-120" water maximum static and differential, two pointers and ranges available), (b) the readability of our indicator.



Try this, for instance. Unless the 5:18 is crowded tonight, hold this page at arm's length. Now you see the indicator as you would at 19 feet. That 0.2" water full scale range is less than the draft required to puff a filter tip! If you're interested in a continuous record those same ranges are available in our circular chart OT Recorder line. Both instruments have an accuracy of ±2% of range and are available with square root extractors for flow applications.

For further garnishment, send for our bulletin 56-350-16. That bulletin number again: 56-350-16. In the suburbs and for the recorder it's bulletin No. 57-232-25.

Phil Sprague Jr.
President

THE HAYS CORPORATION • MICHIGAN CITY, INDIANA

For more information circle **6** on inquiry card.

Varian Strip Chart Recorders

POTENTIOMETER PERFORMANCE* AT MODERATE COST

Varian G-10 — Portable for laboratory or bench use where chart accessibility is of prime importance. Base price $340.

Varian G-11A — For panel, rack or portable use; designed for OEM, lab or field for long-term monitoring. Base price $450.

* The servo-balance potentiometer method has long been used in expensive recorders to achieve superior stability, sensitivity, ruggedness and high input impedance. Use of servo balancing systems assures full realization of these inherent advantages by providing ample power independent of the source being measured. Now Varian offers you recorders of moderate cost using this time-proven principle.

VARIAN SPECIFICATIONS:

- Spans as low as 10 mv
- Limit of error 1%
- Maximum source resistance 50K ohms or higher
- Balancing times: 1 second or 2.5 seconds on G-10; 1 second on G-11

WRITE TODAY FOR COMPLETE SPECIFICATIONS

Varian recorders are sold and serviced throughout the free world by representatives in principal cities.

VARIAN associates
INSTRUMENT DIVISION
PALO ALTO 27, CALIFORNIA

Varian Associates manufactures Klystrons, Traveling Wave Tubes, Backward Wave Oscillators, Linear Accelerators, Microwave System Components, R. F. Spectrometers, Magnets, Magnetometers, Stalos, Power Amplifiers and Graphic Recorders and offers research and development services.

For more information circle **7** on inquiry card.

LETTERS—CONTINUED

It would be of great interest if a section of your publication could be set aside monthly for information on digital computers, their use, new advances or other information of general interest.

Henry Z. Nalo
Remington Rand Univac

The "Digital Automation" series is now in its 25th month, the new products and new literature departments report ALL new computer developments, and there is additional basic material on computers and electronic circuitry in each issue.

Editor, I&A:

In "Letter from Costa Rica" in September 1957 issue by Rafael W. Keith, San Jose, Costa Rica, this pioneering educator asks for examples of "lab" exercises in basic measurements, electricity, and so on . . . . . As a Cornell alumnus, educator Keith may know of the work of Dr. Lynn Emerson, who occupied the chair of Industrial Education at Cornell for some years, and who developed in his National Defense Curriculum Laboratory a series of laboratory manuals, notably in the fields of Measurement, Gaging, and Inspection.

As Dr. Emerson's assistant, I prepared a laboratory manual, "*Electrical Measurement*," describing the making and testing of a series of wire meter models which I had developed while organizing and teaching the first radio courses in New York State public schools (1930-1940). The manual was published by the Vocational Department of the University of the State of New York, and during the war received rather wide distribution, exhausting several editions. I do not know if this book is now available, but if so it would appear to fit the needs of "do-it-yourself" schools where the laboratory facilities are limited. (My first public school radio laboratory was set-up in an empty coal bin!)

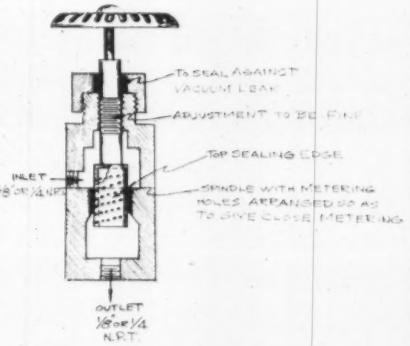
If the manual is of interest, I suggest writing to Eugene D. Fink, Department of Industrial Education, University of the State of New York, Albany, New York. Mr. Fink, the instigator of this series of publications, may be able to locate a few samples, as requested by Mr. Keith.

Edward J. Madden
USA Engineer Research & Development Laboratories
Fort Belvoir, Virginia

Editor, I&A:

I am interested in purchasing a micro-metering Valve for extremely close vacuum metering service. The application calls for an exact reading of a depth gauge to .0001" and a 100" water Manometer to tenths of an inch.

We have tried several micro-metering needle valves, without success.


To SEAL AGAINST VACUUM LEAK
ADJUSTMENT TO BE FINE
TOP SEALING EDGE
INLET 1/8 OR 1/4 N.P.T.
SPINDLE WITH METERING HOLES ARRANGED SO AS TO GIVE CLOSE METERING
OUTLET 1/8 OR 1/4 N.P.T.

See attached sketch for type of metering valve desired. As you can see the valve works on the adjustment of the spindle and the number of minute holes allowed to be above the top seating edge. For example it may take 8¾ holes for a desired pressure.

Do you know of any manufacturing firm that makes this type of valve or one that would give us the desired metering?

Jerry N. Brooks
Bendix Aviation Corporation
Hamilton Division
5th St. and Ford Blvd.
Hamilton, Ohio

This idea looks promising. Respondents can write directly to Mr. Brooks or to us, mentioning inquiry number A-277.

Reader Inquiries

Moisture in Fabrics

Consulting chemists are seeking instrument measuring moisture in a fabric while in motion. Instrument is to be mounted on stenter frame to help control speed. A-278

Pure Tin Wire

Instructor in biology department of Junior College seeks supplier of pure tin wire of 1/16" dia. A-279

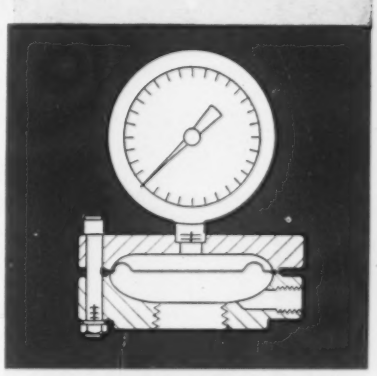
High-pressure Pickups

Chemist in large research laboratory is interested in finding sources that could supply manganin-resistance high-pressure pickups. A-280

Predetermined Counter

Manufacturer of precision cams is looking for commercially available device (1) to manually set a number of five digits on dials, (2) push a button, and (3) get the preset number of revolutions on the output shaft of a motor. Dials then are to reset to zero. A-281

WHAT'S INSIDE MAKES A BIG DIFFERENCE



Vulcan diaphragms have been accepted and depended on for almost 25 years.

Low gauges are available with excellent flexibility for delicate applications. Heavy gauges with high strength for rugged service are available in many coating compound types.

Vulcan provides integrated research, development and manufacturing facilities. This means complete quality control from raw material to finished product; assuring you that every diaphragm is made to strict specifications.

A vital part of this Vulcan integration is our research and development laboratory. If you have a diaphragm problem, we shall be happy to consult with you.

Another
REEVES VULCAN
RUBBER PRODUCT

Write to: Dept. 1-11
REEVES BROTHERS INC.
Vulcan Rubber Products Division
54 Worth Street · New York 13, N.Y.

For more information circle 8 on inquiry card.

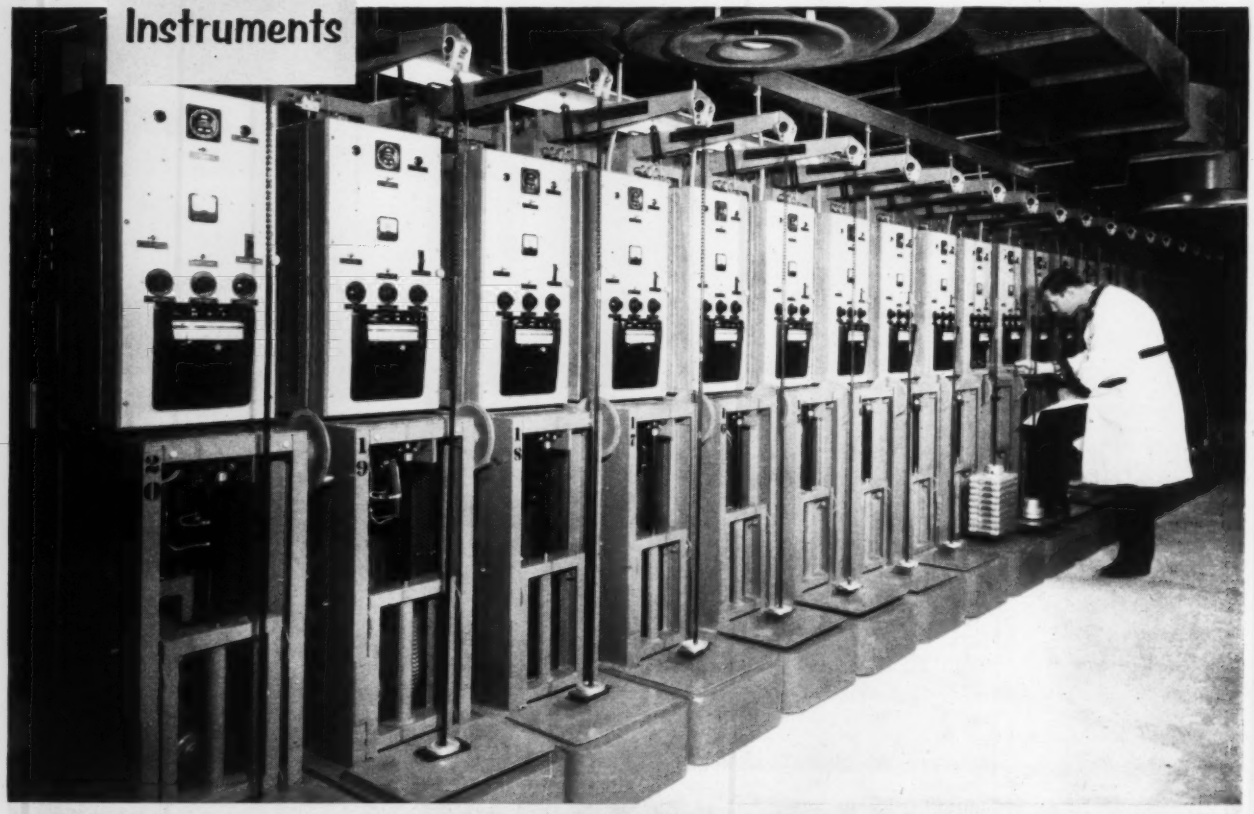
THE MARK OF QUALITY

BARBER COLMAN

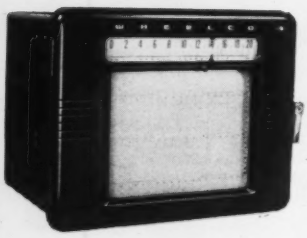
Wheelco Instruments

"Better than standard test performance"

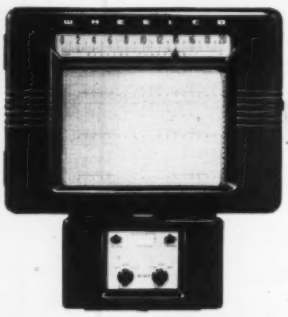
with Wheelco Instruments...



HERE ARE OTHER PEAK PERFORMERS



Multi-point Recorders and Recording Controllers — null-balancing instruments feature swing-out design for easy chart and instrument maintenance . . . Multi-points record up to 16 points on a single chart . . . single or multi-color printing.



Automatic Reset Controllers — for demanding processes where small capacitance requires wide proportional settings and offset cannot be tolerated . . . tamperproof cover protects all adjustments, yet leaves controls available to operator.

For more information circle 9 on inquiry card.

Instrument standardization shows results in outstanding performance at Joliet Metallurgical Laboratories

It's Wheelco — all the way — in this modern testing installation at Joliet Metallurgical Laboratories, Inc., Joliet, Illinois. Outstanding performance on creep and stress-rupture tests depends in large measure on the proper application of modern instrument standardization in terms of temperature control.

To achieve this outstanding temperature regulation — well within ASTM specifications — Joliet Metallurgical Laboratories chose Wheelco 407 saturable-reactor Capacitrols for use on their Arcweld creep-test machines. Materials tested range from alloys of magnesium, aluminum, and titanium, through the stainless steels to the superalloys — a temperature span from approximately 400° to 2200° F.

Why did an organization with high-performance requirements standardize on Wheelco in this test battery? High degree of accuracy and reproducibility are the leading reasons — but low initial cost and an impressive maintenance record are extremely important in the decision.

In a test setup like this one, just as in numerous other installations, Wheelco's famous plug-in chassis eliminates countless maintenance headaches. That's why it pays to standardize on Wheelco Instruments. A spare chassis — prechecked and ready to go — can be inserted and the malfunctioning unit taken to the shop for checking under ideal conditions.

You'll find more advanced design features in Wheelco Instruments than in conventional units that only look similar. Your broadly experienced Wheelco field engineer will help you survey your instrument needs and point out where your processing can be improved materially with the proper instrumentation.

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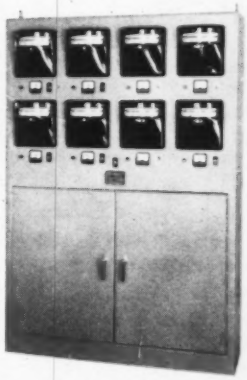
FROM WHEELCO...

Capacitrols — companion to the 400 Series featured above are these horizontal "Panel-mount" types. Both styles are available in a variety of control forms: time-proportioning, two-position, Multronic, proportional-position, and electrical-proportioning.

Indicating Pyrometers — built to highest standards for precision instruments . . . feature meter movement with Alnico V magnet and electrical compensators for resistance changes in the metering system.



Packaged Control Centers — rewired, prefabricated Wheelco control provide major savings by simplifying installation and incorporating instruments and accessories in a single unit. Instruments shown here plus any others in the complete Wheelco line can be combined in a single attractive and efficient unit.

For more information circle 9 on inquiry card.

LEWIS PORTABLE PYROMETER POTENTIOMETERS

FOR MEASURING TEMPERATURES ELECTRICALLY

- IN MOVING VEHICLES
- IN AIRCRAFT
- IN THE LABORATORY

ACCURATE, DIRECT-READING, EASILY-OPERATED INSTRUMENTS, WITH ELECTRICAL COLD-JUNCTION COMPENSATION.

These potentiometers have been used for years by the leading motor car and aircraft manufacturers for proving-ground and flight-test work as well as in the laboratory.

- Three models from which to choose the instrument for your application.
  Model 13PO2, with single temperature scale.
  Model 14PO (illustrated) with high and low temperature scales.
  Model 78PO with one temperature and one millivolt scale or two temperature scales, for different thermocouple materials.
- Housed in a sturdy hardwood case, approximately 11⅜" long, 10" wide and 7⅞" high. Weight approximately 17 lbs., shipping weight 20 lbs.
- For dependable temperature instrumentation, use these potentiometers with LEWIS leads, selector switches and thermocouples.

THE LEWIS ENGINEERING CO.

NAUGATUCK, CONNECTICUT

Manufacturers of Complete Temperature Measuring Systems for Aircraft

For more information circle **10** on inquiry card.

INSTRUMENTS and AUTOMATION Trends

Annual sales of transistors and other semiconductors could reach $1 billion in next ten years, says J. H. Sweeney, manager of marketing for G. E.'s Semiconductor Products Department. This year sales of semiconductors are expected to reach $140,000,000. This is increase of 82% over sales in 1956; 40% over predictions made last December for 1957.

Government spent $1.2 billion in 1956 for missiles; may spend more than $2 billion in 1958. Instrument Industry will benefit accordingly.

Electronic Associates, Inc., a leading analog-computer manufacturer reports that in 1952, 70% of company's operations were logged in government work. By 1953 that figure had dropped to 50% and at present government contracts account for only about 17% of total output. Industrial market is becoming increasingly important—at long last!

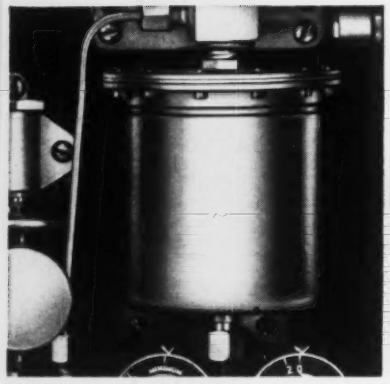
Electrical industry exceeded $34.8 billion sales in 1956, up $6 billion over 1955, after holding steady since 1951. Capital spending in 1957 for utility equipment (generation, distribution and transmission) is expected to be 23% over 1956. Modern equipment uses more instrumentation.

U. S. refinery capacity is now about 15.4 million barrels/day, of which 8.7 million is crude distillation, 3.6 million catalytic cracking, 1.3 million thermal cracking, 1.1 million catalytic reforming. Industry plans about 1 million barrel/day expansion in 1957, of which 0.37 million will be catalytic reforming—because of demand for higher-octane fuels available from the catalytic reforming process. Trend to higher octanes increases accent on precision process instrumentation.

First hydroelectric plant in USA was built in 1882 at Appleton, Wisc; generated 12½ kw. Today, water power develops more than 50 million hp in USA and Canada.

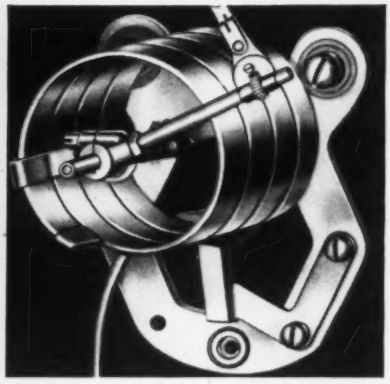
In 1900, electric utility generating capacity in USA was about 1 million kw; in 1925 it was 21.5 million kw; in 1954 it exceeded 100 million kw. Present capacity is comprised of about 75% fuel-burning and 25% hydroelectric plants. Fuel plants are about 96% steam plants, 3% internal-combustion plants, 1% gas turbine. Total capacity is expected to exceed 200 million kw by 1965.

Hotels spent $50 million for electronic equipment (TV, radio, public-address, and air conditioning controls) in 1956, estimates E. Lurie of American Communications Corp.



RESET ACTION STOPS (*in cylinder*), another Bristol exclusive on reset models, assures optimum control recovery after sustained deviations of variable from set point.

ZERO DERIVATIVE SETTING, exclusive with Bristol on derivative models, can cut hours from set-up time for new process or new process conditions.



PRECISION BRISTOL MEASURING ELEMENTS, like this helical pressure element, promote accuracy of measurement and process control.

Your newest man can operate and

Several hundred standard models meet every process requirement including:

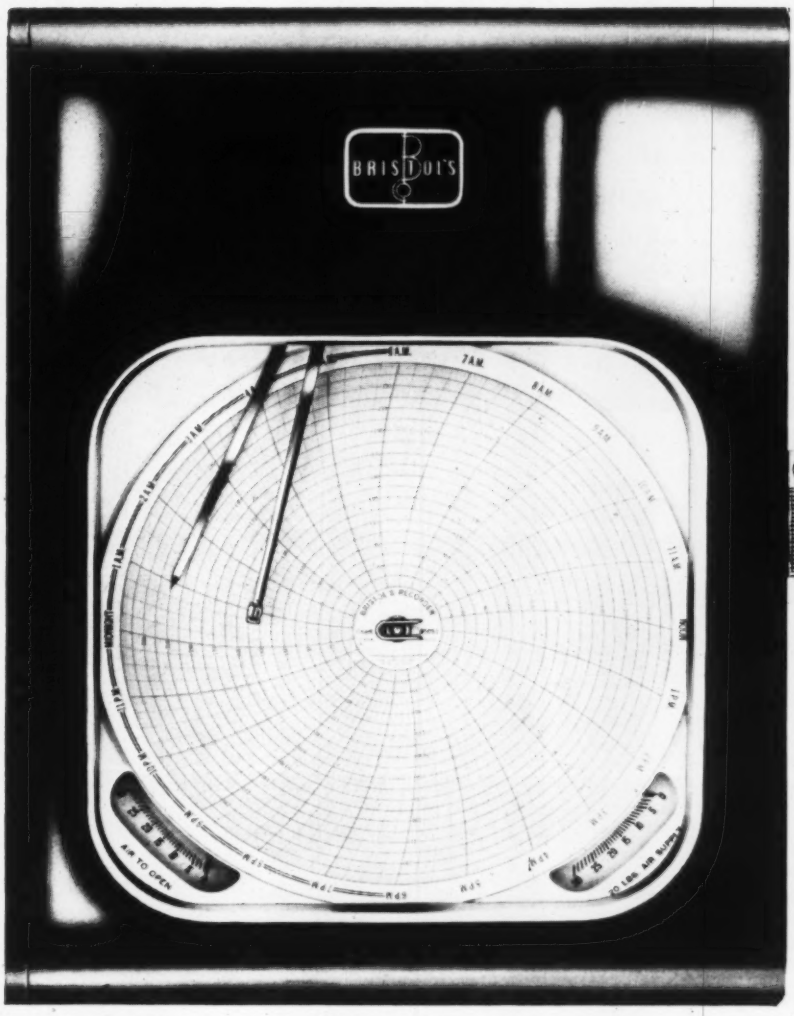
These problems:

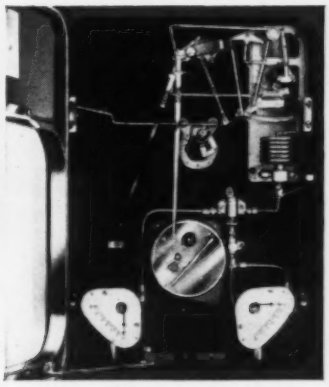
1. Cascaded control
2. Selective control
3. Ratio control
4. Time program control
5. Pneumatic Transmission

These operating modes:

1. Fixed narrow band (on-off)
2. Proportional—to 100% and to 30%
3. Reset with wide band—rates 0.1 to 10 or 1 to 300 repeats per minute. Proportional band to 400%.
4. Derivative (rate)—Derivative time 0.2 to 20 min., plus Bristol exclusive zero derivative setting.
5. Reset plus derivative—with proportional band, reset rate, and derivative time as given above.

For more information circle **11** on inquiry card.





FIXED LINKS AND LEVERS provide built-in calibration in Bristol Series 500 Controllers. There's literally nothing to go wrong. This proportional temperature controller (chart removed) shows basic instrument simplicity.

maintain this controller

He'll catch on quick to the Bristol Series 500 Controller without a complicated, lengthy training period.

In fact, your plant can have Bristol Series 500 Controllers, even if you don't have a formal instrument department at all. Many small instrument users are doing this today. Yet the 500's performance is such that one of the largest, most widely known chemical companies in the country *just bought seventy 500's for its exacting processes.*

Two outstanding reasons contribute to this precision and trouble-free performance: (1) *Basic simplicity* of the operating mechanism—there's literally no way the instrument can get out of order or out of adjustment. (2) Bristol measuring elements insure the utmost accuracy in automatic control—for temperature, pressure, vacuum, draft, absolute pressure, liquid level, humidity, pH value, electrical measurements, or any variable.

Another big simplification: You can exactly calibrate the Series 500 Controller *with only one single adjustment, even after complete disassembly and reassembly with replacement of parts.* Close tolerances on all working parts plus the built-in calibration of the fixed-link-and-lever mechanism make this possible. And you can always interchange parts with those of any other Series 500.

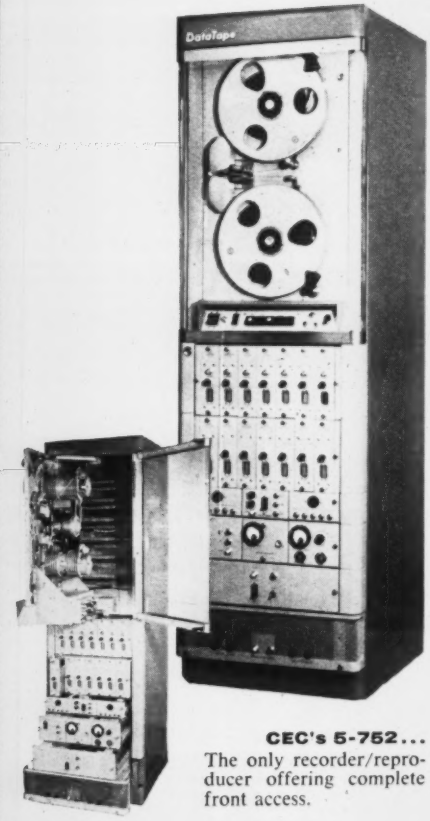
Get complete data on Bristol Series 500 Pneumatic Controllers now, before you order another instrument. You'll find a model for every purpose, every mode of control. Write for bulletin A 130, The Bristol Company, 113 Bristol Road, Waterbury 20, Conn. 7.49

BRISTOL *TRAIL-BLAZERS IN PROCESS AUTOMATION*

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

For more information circle **11** on inquiry card.

DataTape



CEC's 5-752...
The only recorder/reproducer offering complete front access.

standard of the missile range

CEC's MAGNETIC TAPE RECORDER/REPRODUCER

Selected in competitive tests for Air Force and Navy ranges... meets IRIG Specifications...

Simplify your data problems... get instantaneous playback with CEC's new 5-752 RECORDER/REPRODUCER SYSTEM. Handles Analog, PDM, and FM signals.... provides up to 14 tape tracks for simultaneous recording and reproduction of separate signals on one-inch tape. Features CEC all-metal surface magnetic heads. Constructed to meet MIL-E-4758A. For complete data, contact your nearby CEC field office, or write for Bulletin CEC 1576–X9.

TYPICAL APPLICATIONS

Telemetering from Missiles and aircraft, including FM sub-carrier telemetering • Wind-Tunnel Testing • Jet and Rocket Engine Testing • Studies of Shock and Vibration • Mobile and Stationary Structural Testing: ships, trains, etc. • Static and Dynamic Testing: airframes and components • Sound Measurements: all types of analyses, including sonar, medical research.

DataTape Division

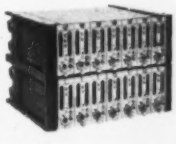
Consolidated Electrodynamics

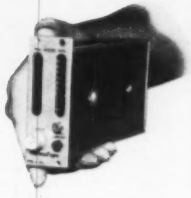
300 North Sierra Madre Villa, Pasadena 15, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For precision in-flight recording, or wherever small size and portability are paramount, DATATAPE RECORDER provides up to 14 tape tracks. This compact recorder provides complete compatibility with the 5-752, guarantees accurate performance under severe environmental conditions (MIL-E-5272A, Proc. 1), and operates at extremely high temperatures to 100°C.

CEC's 1-001 Amplifier Case houses seven record amplifier modules in the smallest package on the market today. Rugged construction provides rigid mounting of modules. Coolant air is provided for operation up to 100°C. Stringent environmental specifications are met without the use of shockmounts.





10-12 oz. Miniature Record Amplifiers feature printed wiring, combination subminiature-tube and transistor circuitry, modular construction, and high-temperature operation to 100°C. Aluminum die-cast packages, 6¼″ long by 3¼″ high and 1 3/16″ wide, provide FM, PDM, and Analog recording.

For more information circle **12** on inquiry card.

MINNIE

MINIATURE CONNECTORS

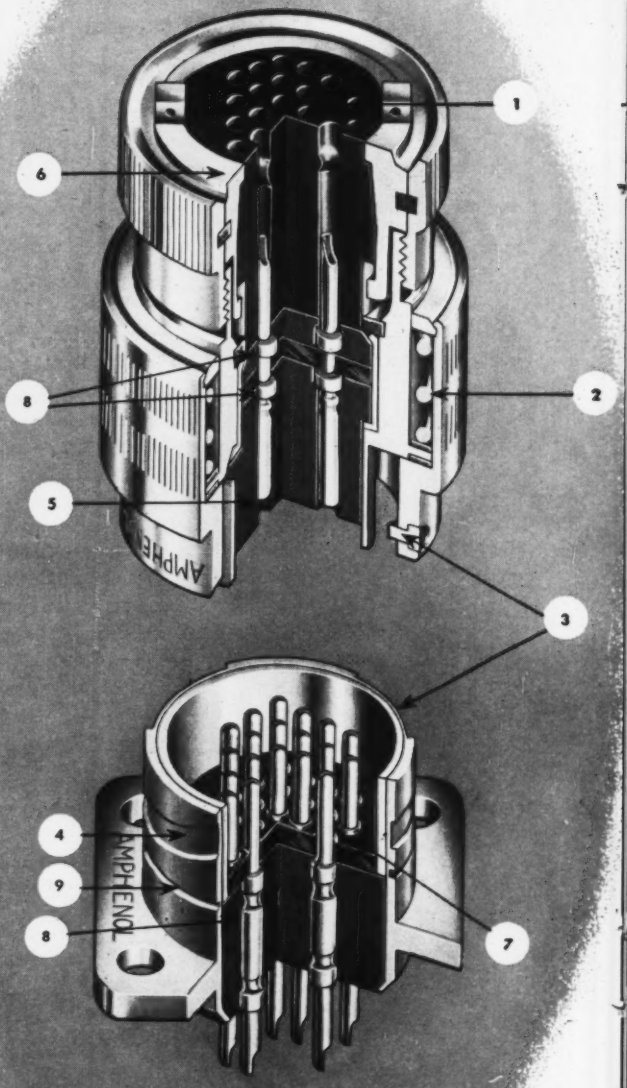
. . . the only miniature connector line fully conforming to the "E" REQUIREMENTS OF MIL-C-5015C.

Meet minniE—a complete line of miniature connectors with outstanding reliability features! The first miniatures to meet fully the "E" performance requirements of MIL-C-5015C, minniE's are environmentally sealed to resist moisture and humidity; ruggedly built to resist shock and vibration; imaginatively designed to provide application versatility.

FEATURES

1. Environmentally sealed with unitized back end grommet. (Also available with provision for potting.) Either grommet seal or potted seal meets moisture resistance requirement of MIL-C-5015C, Paragraph 4.5.21.
2. Spring-loaded coupling ring provides a positive locking action in the bayonet slot, and a constant compensating force which eliminates the effects of resilient face seal compression set.
3. Stainless steel bayonet slots and pins reduce wear and frictional characteristics. The three pin bayonet coupling minimizes the rocking action of the mated plug and receptacle.
4. Flattened incline angle of bayonet slots reduces mating force requirement.
5. Hooded contacts resist test prod damage as defined in Paragraph 4.5.14 of Amphenol Specification 340-43-2108.
6. Unitized grommet seal; clamp and grommet form a single unit for ease of assembly and maintenance.
7. Face seal gasket with individual barriers to isolate each contact.
8. Hard insert dielectric (plus resilient face seal) positively retains contacts with no possibility of contacts being pushed out of the insert.
9. A visual full engagement indicator is included in the design to insure the user that he has fully engaged the connectors. The indicator is an orange line around the receptacle shell.

- When using mated sealed connectors, no derating for altitude is necessary at 70,000 feet.
- Test voltage 1,500 volts RMS 70,000 feet on sealed connectors.
- Vibration per Method 204 of MIL-Std-202A. 10 to 2,000 cps at 20 g's.
- Temperature cycling range per MIL-C-5015C, Paragraph 4.5.3 increased to 257°F. maximum and —67°F. minimum.



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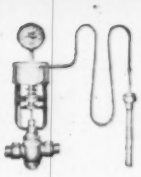
AVAILABILITY:

4 CONSTRUCTIONS: "E", Potting, Jacketed Cable, Cable Clamp
5 SHELL SIZES: 12, 14, 18, 20, 22
17 INSERT ARRANGEMENTS: Up to 48 contacts; coax and hermetic seals also

For more information circle **13** on inquiry card.

HOW TO PICK THE BEST REGULATOR FOR TEMPERATURE · PRESSURE · LEVEL

It pays to use Fulton Sylphon Regulators as your starting point in selecting controls. With the broadest line of self-operated regulators, Fulton Sylphon has the *one best* solution for any regulator application. You get the accuracy and performance the application requires without spending a cent extra for features you don't need.

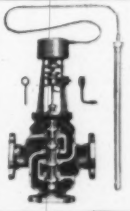


REGULATORS WITH THERMOMETER

Regulator controls temperature . . . thermometer shows it. Dial serves as check on regulator operation. Also permits swift, accurate changes of control setting. Adjustable ranges from 20° to 480° F. Various bulb styles and materials.

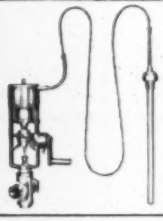
STANDARD TEMPERATURE REGULATORS

Control liquid, air or gas temperature by throttling heating or cooling supply. Extra-large Sylphon® bellows assures positive valve positioning with high flow pressures. Over-run protection. Adjustable ranges from 20° to 480° F.



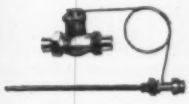
MANUAL OVER-RIDE REGULATORS

Self-powered regulator automatically controls liquid, air or gas temperature. Crank permits manual valve positioning at any time. Provides quick shut-off or full-open operation. Adjustable ranges from 40° to 330° F.



QUICK-ADJUSTMENT REGULATORS

Turn of a crank quickly adjusts regulator to any control setting within range. Ideal where control point is changed frequently. For liquids, air or gases. Ranges between 40° and 480° F.

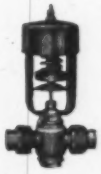


STEAM HEATING REGULATORS

Packless, dial adjusted types control liquid, air or gas temperature by throttling steam 75 psi or below. Calibrated dial on bulb types speeds control settings. Adjustable ranges from 35° to 110° F. Liquid and air type bulbs.

SAFETY TEMPERATURE REGULATORS

Regulator maintains liquid, air or gas temperature and can also turn valve full-closed or open as specified if bulb or tubing is damaged. Protects equipment and production. Adjustable ranges from 50° to 245° F.



PRESSURE REGULATORS and CONTROL VALVES

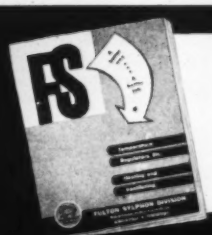
Act as pressure reducers, pump governors, relief valves, for constant pressures from 60 to 2 lbs. Vacuum regulators also available.

FULTROL PILOT CONTROLLERS

Low-cost pilot modulates air or hydraulic pressure to valves, dampers, other devices. No troublesome pivots or levers. Adjustable 25° F. proportional band. Dial settings. Ranges up to 600° F.

LIQUID LEVEL CONTROL

Simple, direct-acting float valve controls level of liquids or slurries in open reservoirs. Corrosion-resistant and sturdy. Single-seated or double-seated valves in sizes from ¼" through 4".



For Descriptive Data On The Full Line Of Fulton Sylphon Regulators

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FULTON SYLPHON • TEMPERATURE REGULATOR HEADQUARTERS, U. S. A.

For more information circle **14** on inquiry card.

News

International Federation of Automatic Control (I.F.A.C.) Chartered

PARIS, FRANCE.—AFRA, the French Association of Regulation and Automation, played host on September 10, 11, and 12, 1957 to delegates of 19 countries who had assembled to hear an address by Marcel Mamy, AFRA's vice-president. Mr. Mamy acted in the absence of president Mr. Loeb who had to extend his stay in the United States.

In his address Mr. Mamy confirmed that a National Center of Automatisation had been founded by three powerful industrial concerns: one mechanical, one electrical, and one electronic. The Center will be of valuable guidance to AFRA.

As representative of the French government, Mr. R. Lescop, director of mechanical and electrical industries in the Industry and Commerce Department, addressed the delegates and praised the charter of IFAC as a decisive phase in the progress of humanity.

At the opening session two papers were delivered—one by Mr. M. Chalvet on "Some Characteristics of Automation and their Consequences," the other by Mr. G. Lehmann, who spoke on France's contributions to the art of automation.

Prof. Victor Broida, as president of the provisional committee (France), then reported that in September 1956 at the conference in Heidelberg (West Germany) a committee of 6 was formed to study the constitution of an international association. The committee had been invited by AFRA to come to Paris December 18 and 19 to finalize the constitution, which was followed up in Duesseldorf on the basis of French and American proposals.

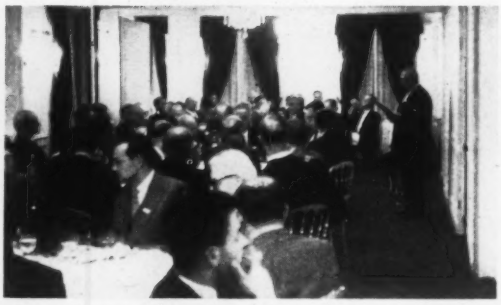
On September 11, the second day of the congress, the constitution was discussed and its 45 articles adopted. After determining the annual dues of the various countries the Federation was declared founded at 5 P.M.

On September 12, the third day of the meeting, the general assembly decided to establish the office of its secretary at Dusseldorf (West Germany).

The executive Board was then elected for a two-year term, as follows:
Harold Chestnut (USA), president; Prof. A. M. Letov (USSR), first vice-president; Prof. V. Broida (France), second vice-president; G. Lehmann (France) treasurer; Dr. Ing. G. Ruppel (West Germany), secretary; and M. Ajnbinder (Belgium), J. F. Coales (England), Prof. B. Evangelisti, (Italy), Prof. E. Gerecke (Switzerland), Prof. P. Nowacki (Poland), and Prof. Tsien (China)—members.

It was decided to hold a World Congress of the IFAC in Moscow in 1960 or, time for preparations permitting, in 1959.

The 19 nations officially represented were: Austria, Belgium, China, England, Germany (West), France, Hungary, Italy, Japan, the Netherlands, Norway, Poland, Roumania, Russia, Sweden, Switzerland, Turkey, the United States, and Yugoslavia. Four other countries had sent excuses but joined the IFAC: Denmark, Finland, Germany (East), and Czechoslovakia.



First vice president Marcel Mamy addresses I. F. A. C. delegates from 19 countries.

Prof. Rufus Oldenburger (USA) was on the committee of the general assembly.

The Federation defined "automatic control" in its constitution as "deemed to cover the field of open and closed loop (feedback) control of physical systems (including servomechanisms, instrumentation, data processing, and computers when part of control systems) in theoretical and applied aspects." To push this area of engineering on an international basis is the prime purpose of IFAC, which is pledged to:

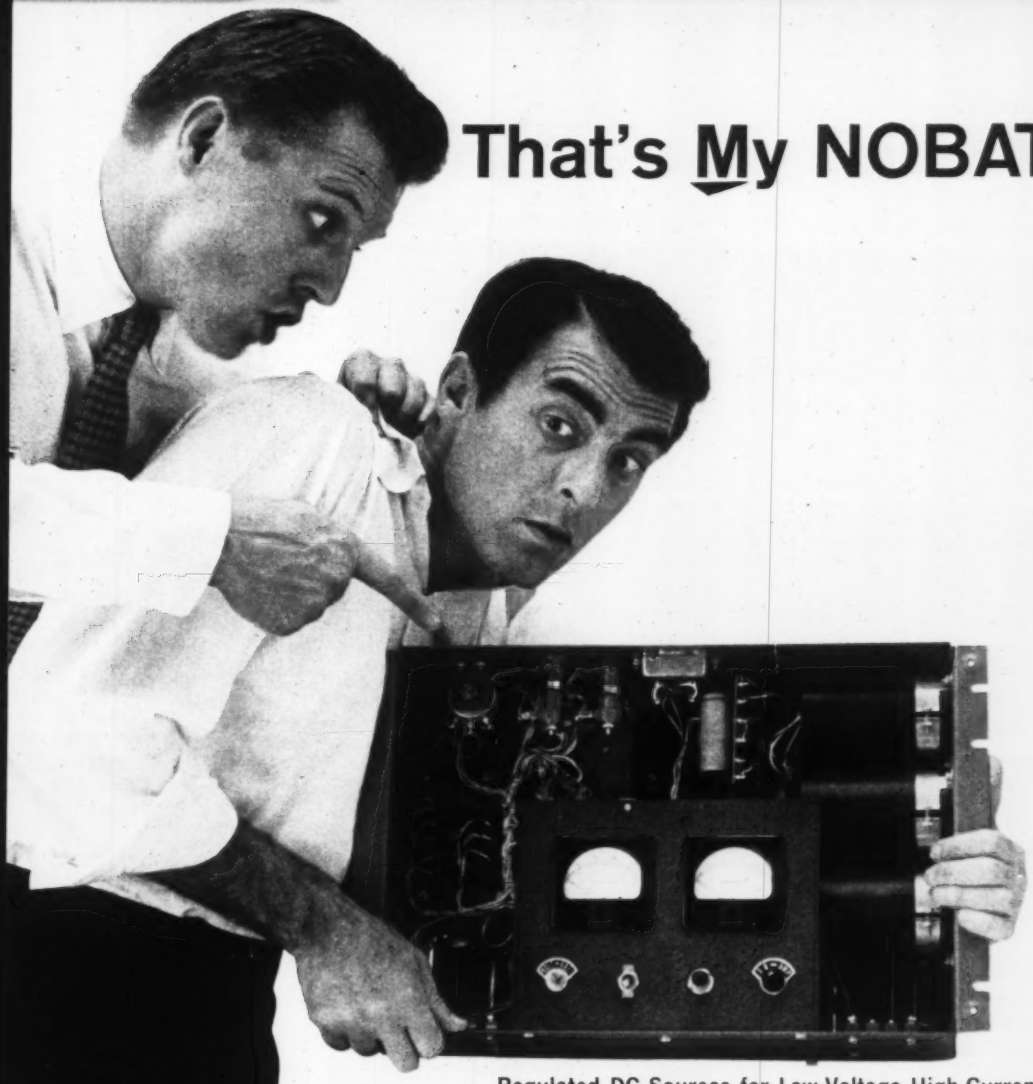
- sponsor international congresses
- promote an interchange and circulation of information of control activities in cooperation with other organizations, and
- take any other steps considered necessary to the realization of its aim, such as printing, publishing, and distributing relevant papers.

Wax-Electrolyte Batteries

WASHINGTON, D. C.—NBS has developed a low-current punched-cell battery which has a waxy electrolyte consisting mainly of solid polyethylene glycol. Such 25-cell batteries, only 0.3″ in length and ¼″ in diameter have an electromotive force of 37.5 volts with a short-circuit current of 3×10^{-8} amp. Shelf life of more than 3 years is another outstanding feature. The immediate objective was to obtain information that can be used in constructing batteries for specific ordnance applications. They are expected to prove useful in maintaining a charge on a capacitor and in producing a grid-bias voltage for radio tubes.

Circle 15 on inquiry card.

That's My NOBATRON®!



Regulated DC Sources for Low-Voltage High-Current— 6, 12, 28, 48, 125, 200 Volts at 5 to 75 Amps.

For a reliable *sustained* low-voltage DC supply, delivering the power that covers most laboratory and many industrial applications, and with voltage variation held within ±0.2%...these Nobatrons just can't be matched—by anything, anywhere.

Nobatrons are in use, by the thousands, all over the world. Many of them have been in operation continuously over a span of years. Conservative design and generous specifications insure long life—especially for wound components.

So effective is the Sorensen regulating principle in correcting line and load drops that output has the stability of a battery supply over extended periods. And the disadvantages of batteries—recharging, acid handling, fixed voltage, temperature problems—are eliminated.

Over-voltage protection is assured by a special safety diode that impels a voltage drop in case of filament failure, with other protective devices safe-guarding all components against power surge.

Most units are designed for rack-mounting, and with cabinets for bench use.

Let your local Sorensen representative give you complete data on these Sorensen DC Nobatrons or write directly for specific information. Please address **SORENSEN & COMPANY, Inc.,** *Richards Avenue, South Norwalk, Connecticut.*

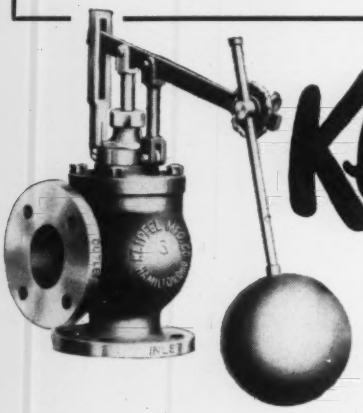
TYPICAL SPECIFICATIONS Model E-28-5* (illustrated)

Output Voltage	28 VDC, Adjustable ±10% with rated accuracy	**Load Range**	0.5 to 5 Amps at Rated Accuracy; accuracy decreases to around ±0.5% for no load.
Input Voltage	95-130 VAC, single phase, 50/60 cycles.	**Ripple Voltage**	1% RMS at 60 cycles. Filters available to reduce ripple to 0.1%
Regulation Accuracy	±0.2% against line from 105 to 125 VAC Input; ±0.2% against load.	**Time Constant**	0.2 second
		Size	Rack height 12¼" Cabinet Size 21¾" x 14" x 15"

*Write for data on other models and capacities.

Sorensen® CONTROLLED POWER FOR RESEARCH AND INDUSTRY

to keep liquids ON-THE-LEVEL



Klipfel

FLOAT VALVES

- Really automatic liquid level control . . . proven by a 40-year record of dependability in thousands of installations, large and small, water and chemical.
- Direct acting or pilot control types . . . single or double seated . . . for every possible requirement of pressure, temperature, fluid and closure.
- Also available with Klipfel's exclusive cup disc inner valve for tight control of liquids injurious to rubber and leather, and for higher pressures.

Get all the facts today on Klipfel Float Valves. Write for catalog #254.

- **FLOAT VALVES**
- **REDUCING VALVES**
- **TANK THERMOSTATS**
- **BACK PRESSURE VALVES**

Klipfel

VALVES, INC.

Division of Hamilton-Thomas Corp.
Dept. D-11, Hamilton, Ohio

Export Dept.—1010 Schaff Bldg., Philadelphia, Pa.

For more information circle **16** on inquiry card.

Electronic Traffic Control

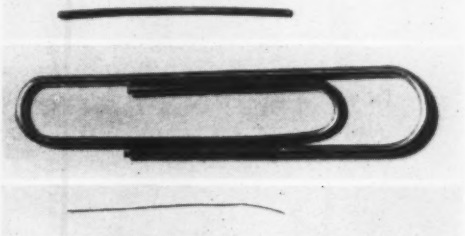
LOS ANGELES, CALIF.—A demonstration of stoplight radio interconnection using an electronic traffic control system recently was held here. The new electronic traffic cop, El-Tec, was developed and is manufactured by Electronic Protection, Inc., a subsidiary of Standard Coil Products Co. The equipment is adaptable to present

signal installations and provides three basic functions: (1) it coordinates all traffic signals from a central multiple control point for evacuation of metropolitan areas under disaster conditions, (2) clears thoroughfares for police, fire and Civilian Defense vehicles from the moving vehicles themselves, by turning traffic signals green in the direction of vehicle approach and red at cross streets, and (3) automatically "programs" metropolitan traffic signals for normal traffic flow demands and for varying "peak periods," such as large concentrations of traffic during rush hours, etc.

The system operates on a frequency of 450-470 megacycles and cannot be "triggered" except by the El-Tec-designed and engineered transmitter.

Tiny Permanent Magnets

WASHINGTON, D. C.—Scientists at the NBS have been successful in perfecting permanent magnets as small as a human hair which retain all the properties of their



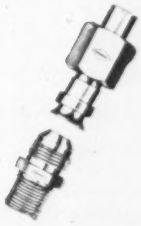
big brothers. Cunife (60% Cu, 20% Ni, 20% Fe) can be cold drawn to diameters as small as 0.005". If subjected to a simple heat treatment, it regains magnetic properties which are satisfactory for many applications such as in magnetometers and galvanometers.

IMPERIAL HI-SEAL® BUTT-JOINT FITTINGS

Foolproof assembly! No need to spring tubing. Permit closer tube bends. Withstand high pressures. Meet J.I.C. and A.S.M.E. standards. For ⅛ to 1½" O.D. tubing. Steel and stainless steel.

IMPERIAL HI-DUTY® FITTINGS

Save 36 to 77% installation time. Withstand severe vibration. Brass and aluminum.



IMPERIAL J.I.C. 37° FLARE FITTINGS

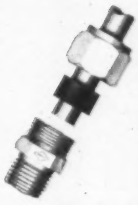
Withstand high pressures and severe operating conditions. Brass, steel, stainless steel.

From ***IMPERIAL . . .***

industry's most complete line of fittings *for metal and plastic tubing*

IMPERIAL ERMETO FITTINGS

No flaring, threading, welding or soldering. Make safe connections that withstand high pressure and vibration. Steel.

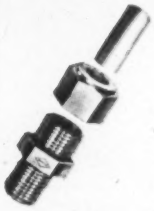


IMPERIAL FLEX® FITTINGS

The brass tube coupling with the vibration and shock-absorbing sleeve. Withstands minor tube movement. Also Nylo-Flex Fittings for nylon tubing.

IMPERIAL POLY-FLO® FITTINGS

For polyethylene or other plastic tubing. Finger tightened only. Save time and labor. Brass.



IMPERIAL NYLO-SEAL® FITTINGS

Made of DuPont Zytel. Economical, corrosion resistant. Save up to 90% compared to stainless steel fittings.

IMPERIAL COMPRESSION FITTINGS

For low pressure work. Simple, efficient, economical. Brass.

IMPERIAL S.A.E. 45° FLARE FITTINGS

Heavy-duty or standard types. Withstand severe tensile pull and high pressures. Brass.

From ***IMPERIAL . . .*** a wide variety of fluid control valves in 4 basic types

NEEDLE VALVES

For accurate regulation of flow. Straight thru and angle types — regular and panel mounted.

TOGGLE VALVES

For quick opening and closing. Straight thru and angle types — regular and panel mounted.

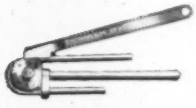
DIAPHRAGM VALVES

Solid Teflon diaphragm withstands unlimited openings and closings. Regular and panel mounted types.

HI-DUTY® "PLUG" VALVES

A superior plug-type shut-off valve. "O"-Ring seal on stem. Solid bottom. 2-, 3-, 4-way types.

TUBING TOOLS TOO! Imperial offers you industry's most complete line for working copper, steel, stainless steel, aluminum and plastic tubing!



IMPERIAL TUBE BENDERS

Lever, gear and spring types.

IMPERIAL FLARING TOOLS

All types for making 45° and 37° flares — single and double flares.

IMPERIAL TUBE CUTTERS

For tubing ⅛" to 2¼" O.D.

See your IMPERIAL distributor *Write for complete catalog 200*

IMPERIAL

THE IMPERIAL BRASS MFG. CO.
6300 W. Howard St., Dept. IA117
Chicago 31, Ill.

Emblem of Quality I

In Canada: 334 Lauder Ave., Toronto, Ontario

For more information circle **17** on inquiry card.

Here's News

YOU'VE BEEN LOOKING FOR

PERCUSO-WELD

A LIGHTWEIGHT PERCUSSION WELDER

8"x8"x14"

A New heavy-duty stored energy welder for laboratory and shop use. Instantly fuses thermocouple wires together or to metallic surfaces to obtain accurate skin temperatures.

EASY, SAFE TO OPERATE

Single knob voltage control and one simplified 5 progressive step capacity control. Voltage cuts off automatically after each weld to insure shock-proof operation.

Weight ——— **23 Lbs.**
Dimensions ——— **8" x 8" x 14"**

Range—5 Step 600-1200-2100-3000 and 3900 MFDS.—with 0-135 volts regulation for each range.

Will fuse 40 Ga. thru 20 Ga. Thermocouple wire.

Visable charging rate and saturation indication by means of a meter.

Compare performance . . . compare ease of use . . . compare cost—This brand new lightweight unit is in a class by itself. Made and backed by the Thermo-Couple Products Company

Write Today for FREE Literature

THERMO-COUPLE PRODUCTS CO. INC.

729 N. ADDISON AVE. VILLA PARK, ILLINOIS

MANUFACTURERS OF THERMOCOUPLES • CONNECTORS • CONNECTOR PANELS

For more information circle **18** on inquiry card.

News Bits

DoALL COMPANY has sent its traveling exhibit on the road for the second season, to show "The Story of Measurement". The exhibit traces history and development of linear measurement standards, techniques and instruments.

DoALL Road Show

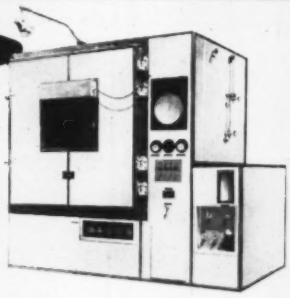
Leslie's 300,000th Control Valve.

LESLIE CO.'s 300,000th control valve comes off the test line as *John S. Leslie*, President, and *S. Inglis Leslie*, Chairman of the Board, look at the impressive 12-incher.

BATTELLE MEMORIAL INSTITUTE research, requiring analysis of metals, ceramics and chemicals on an

DEVELCO

SALT SPRAY FOG TEST CHAMBER



To meet MIL-E-5272 and others.

TOP OPENING
FRONT OPENING
WALK-IN

Write for Bulletin SS-55

DEVELCO

DEVELOPMENT ENGINEERING COMPANY

9 Cross Street • Norwalk, Connecticut

• ***Manufacturers of Environmental Test Equipment***
Fungus Testing - Cold - Heat - Altitude - Humidity

For more information circle **180** on inquiry card.

Circle **173** on inquiry card. ⟶

Fourth International

AUTOMATION

EXPOSITION & CONGRESS

New York Coliseum

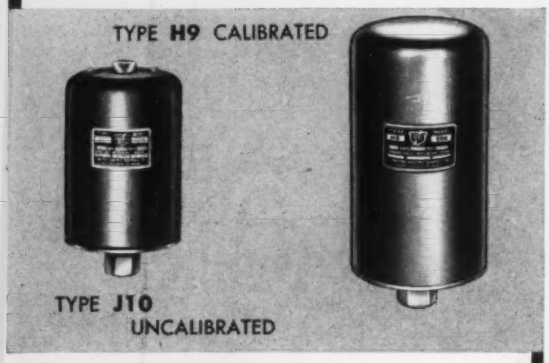
June 9 to 13, 1958

Highlighting the latest developments for increasing productivity in Industry, Research and the Military

Richard Rimbach Associates, Management • 845 Ridge Avenue, Pittsburgh 12, Pa.

Sensitive H9 J10

PRESSURE and VACUUM CONTROLS



UNITED ELECTRIC's Type H9 and Type J10 controls are highly sensitive precision built pressure and vacuum controls designed for applications where close on-off differentials and constant repeatability are required. Type J10, being uncalibrated, is smaller and less expensive than Type H9 which is calibrated and has a knob & dial adjustment.

Specs:	
Various Ranges	H9-J10 — between 30" Hg. Vac. and 15 P.S.I.
Switch Differentials	H9 — ½ to 1 ±1/10" W.C. depending upon model. J10 — ¾ to 1 ±3/10" W.C. depending upon model.
Switch Ratings	Standardly 3 amps 115/230 A.C.
Switch Types	N.O., N.C., or Double throw, no neutral position.
Electrical Connections	Made to screw terminals on switches through clearance hole in enclosure.
Pressure Connections	One ¼" NPT pressure connection.
Size	H9 — 7" x 3⅜" dia. J10 — 6⅛" x 3⅜" dia.
Approximate Weight	H9 — 3 lbs. J10 — 2¾ lbs.

UNITED ELECTRIC *manufactures a complete line of temperature, pressure, and vacuum controls. For applications requiring custom-built units or modified standard units, call upon a UE application engineer for recommendations. Write for complete specification and pricing data on the Types H9 and J10. Similar data available on all other UE controls.*

United Electric Controls COMPANY
85 SCHOOL STREET, WATERTOWN, MASS

For more information circle **19** on inquiry card.

NEWS —CONTINUED

extremely fine scale, will be aided by their newly designed electron probe microscope. Built at the Institute, it can isolate for analysis a region less than 1/10,000 of an inch in diameter on any element from aluminum through the remainder of the periodic table.

APPLIED RADIATION CORP. is constructing a high peak power linear accelerator as an injector for the M. I. T.-Harvard University 6-billion-volt electron synchrotron, at Walnut Creek, Calif.

BUREAU OF BUDGET'S 1957 Standard Industrial Classification manual (SIC) now has subdivisions of major group 36 (Electrical Machinery Equipment & Supplies) devoted to electronic components.

RETMA—Radio-Electronics-Television-Manufacturers Assoc.—has voted to change its name to Electronic Industries Association (EIA).

DAYSTROM, INC. has reorganized a number of its subsidiaries into an Avionics Group "for development and manufacture of complete electronics systems for the guidance and control of missiles and aircraft."

ARGONAUT INSURANCE has installed a Datatron electronic data processing system in its Menlo Park office.

Stock Report

Any further information concerning any of the following issues may be obtained from the Research Department, Bache & Co., 36 Wall Street, New York 5, N. Y.

New York Stock Exchange:

NEW YORK STOCK EXCHANGE

Price Range For 1957
Thru October 15th

	HIGH	LOW	PRICE AS OF OCTOBER 15th
ACF Industries	64 7/8	39¼	46½
Aeroquip Corp.	31 3/8	19 1/8	23 1/4
Allis Chalmers	36 1/4	26	26 3/4
American Chain & Cable	64 1/4	44	44 1/8
American Machine & Foundry	43 3/4	31	32 3/8
American Machine & Metals	58 3/4	41	47 3/4
American Optical	37 7/8	31 3/8	33
American Tel. & Tel.	179 7/8	167 7/8	168 3/4
Beckman Instruments	47 3/4	26 7/8	31 5/8
Bell & Howell	50 1/2	36 1/2	40 1/4
Bendix Aviation	66 3/4	43 1/4	47
Boeing Airplane	61 1/8	29	34 1/2
Bullard	29 1/8	12	13 3/8
Bulova Watch	21	14 1/4	14 1/4
Burroughs	52 3/8	33 7/8	39
Carborundum	51 1/4	32 1/2	35
Cincinnati Milling Machine	50 1/2	34	35
Clevite	25 1/2	18	20 1/2
Columbia Broadcasting "A"	36 1/8	25 1/4	26
Consolidated Electronics	35 1/2	21 7/8	22 7/8
Cornell Dubilier	27 1/2	16	17
Corning Glass	106 1/4	57 1/4	78 3/4
Curtiss-Wright	47 3/8	29 1/2	33
Cutler-Hammer	64 3/4	38 1/2	41 1/4
Consolidated Electrodynamics	54 3/4	31 1/4	35
Daystrom	47	29 5/8	35
Douglas Aircraft	91	50 5/8	62
Eastman Kodak	115	81 3/4	90 1/2
Eaton Manufacturing	64 1/4	43	44 3/4
Electric Auto Lite	40 3/8	30 1/4	32 5/8
Elgin Watch	14 1/8	8 1/4	8 5/8
Emerson Electric	34	23 3/4	26 3/8
Food Machinery & Chemical	65 1/4	47 1/4	48 1/2
Gamewell	36 1/2	23	23 1/2
Garrett	54	25 3/4	29 1/2
General Dynamics	68 5/8	46 3/4	53 1/4
General Electric	72 3/8	52 3/8	59 7/8
General Instrument	8 1/8	5	5 1/4
General Mills	69	56 1/4	57 1/2
General Precision Equipment	47 1/4	30 1/4	33 3/4
General Railway Signal	34	22	24 3/8
General Telephone	45 1/4	38 1/4	39 1/8
General Time	30 1/2	19 3/8	19 1/4
General Tire & Rubber	28	22 1/8	26 1/2

Continued on page 2022

EDISON resistance temperature detectors

provide time constant of less than $\frac{1}{2}$ second

SPECIAL EDISON DESIGN PROVIDES HIGH RATE OF HEAT TRANSFER

An instantaneous response to a change in temperature in monitoring of a guided missile or a motor sleeve bearing could mean the difference of many thousands of dollars in equipment and time. Edison Resistance Temperature Detectors are specifically designed to reduce lag time. Time constants as high as 0.25 seconds have been obtained in special types.

Edison engineers designed these Detectors with rapid heat transfer in mind. The basic element, a low-mass chemically pure nickel or platinum wire, is inherently fast to respond to temperature changes. Couple this fact with such design refinements as using ceramic bushings to cover the fine wire element so that only the tip is exposed to the temperature . . . or providing spring-loaded holders to insure close contact between the detector tip and the surface being measured . . . and flattening the stem, in one instance, so that the heat transfer is more rapid.

These refinements in design are representative of Edison's experience and know-how in temperature control. Other very important features of Edison Resistance Temperature Detectors are elimination of the need for signal amplification, high accuracy and exceptional stability, and hermetically-sealed corrosion-resistant steel wells.

Your need for temperature control means a need for Edison Resistance Temperature Detectors. Write today for complete details. Please state your application.

MODEL 235N90-35
Designed for fast response and high resistance to the corrosive effects of rocket fuels used in guided missiles.
SPECIFICATIONS:
Stem-sensitive.
Useable temperature range −70° to +200°C.
Exponential time constant in agitated waterbath 0.8 second. Maximum hydrostatic pressure on stem: 750 psi at 100°C.
Basic resistance at 0°C = 90 ohms.
Hermetically sealed.

MODEL 242P
This Detector can be operated in live steam or high temperature atmospheres up to 1300°F.
SPECIFICATIONS:
Stem-sensitive.
Useable temperature range −70° to +750°C.
Maximum hydrostatic pressure on stem: 300 psi at 750°C.
Basic resistance at 0°C = 100 ohms.
Hermetically sealed.

MODEL 230N
A general purpose Detector for temperature measurement and control in industrial processes.
SPECIFICATIONS:
Stem-sensitive.
Basic resistance at 0°C = 120 ohms.
Hermetically sealed.

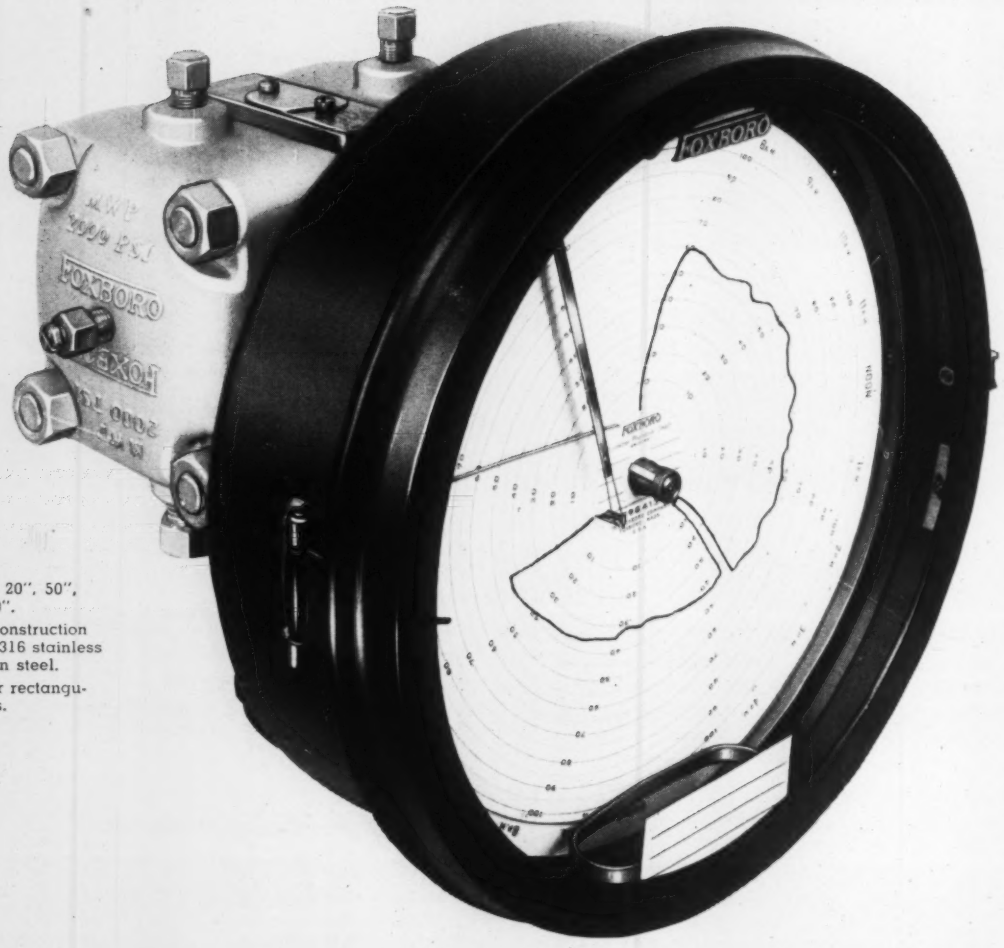
MODEL 166NC
Element is concentrated in tip for sensitivity to surface temperatures in motor bearings, etc.
SPECIFICATIONS:
Tip-sensitive.
Useable temperature range −70° to +300°C.
Basic resistance at 0°C = 120 ohms.

MCGRAW-EDISON

Thomas A. Edison
INDUSTRIES
INSTRUMENT DIVISION
24 LAKESIDE AVE. WEST ORANGE, NEW JERSEY

For more information circle **20** on inquiry card.

NOW... a "Dry" Flow Meter with . .

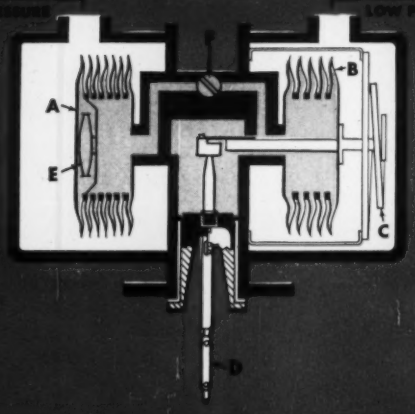


- Ranges: 20", 50", 100", 200".
- Forged construction in Type 316 stainless or carbon steel.
- Round or rectangular cases.

...the new Foxboro Type 37 Diaphragm Meter

How It Works

In schematic drawing at right, areas shown in color represent a stable, non-freezing liquid. Any pressure increase in the high pressure chamber compresses Diaphragm Unit A, displacing its liquid and expanding Diaphragm Unit B until force of Range Spring C equals the difference between the forces on Diaphragm Units A and B. Linear motion of Diaphragm Unit B moves inner end of Drive Bar D — outer end moves correspondingly through the bellows-sealed flexure bar, driving pen arm. Built-in Temperature Compensator (E) proportionately adjusts diaphragm capacity as ambient temperature variations affect volume of filling fluid. External damping adjustment is shown at F.



• complete overrange protection!

• sustained high accuracy!

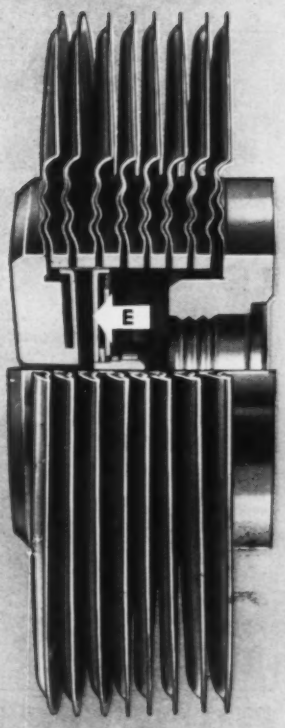
Now you can have mercuryless flow measurement for a wide range of differential pressures — at static pressures up to 2000 psi — with greater safety and dependability than ever before! The new Foxboro Type 37 Diaphragm Meter not only combines unmatched ruggedness and precision in a dry meter — it's by far the easiest to adjust and maintain. And it does away with zero drift problems, once and for all! Expansible, Type 316 S.S. diaphragm elements respond to changes in pressure with unmatched sensitivity, yet are completely immune to overrange up to full static pressure! A unique packless drive bar precisely transmits linear motion to the pen arm. Range-changing is easy, due to new twin-spiral spring design. Wide range damping is externally adjustable under pressure. And the Type 37 is self-compensating for temperature changes in all differential ranges. Get full details on this high utility, completely dependable dry flow meter. Arrange for a demonstration with your nearby Foxboro Field Engineer, or write **The Foxboro Company, 4611 Neponset Ave., Foxboro, Mass., U.S.A.**

FOXBORO

REG. U.S. PAT. OFF.

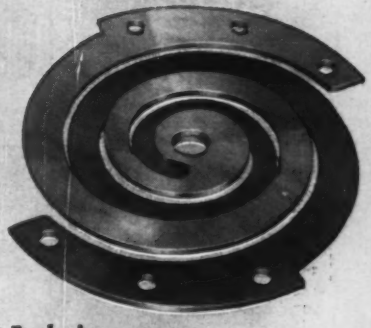
FIRST IN FLOW METERING

For more information circle **21** on inquiry card.



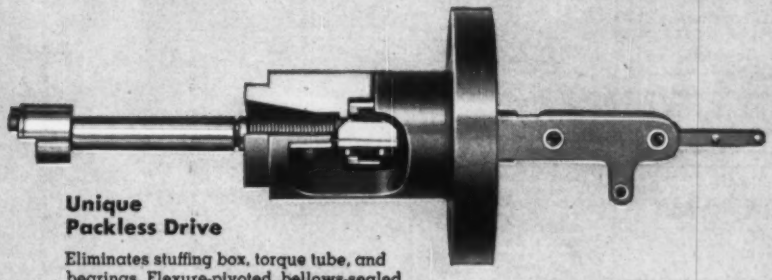
Exclusive Diaphragm Elements

Type 316 S.S. diaphragm units in both high and low pressure chambers provide greatest linearity and freedom from hysteresis; nesting design and integral spacer rings provide safe, positive, overrange protection. Temperature compensation (E) is built into diaphragm assembly . . . never requires change or adjustment.



Exclusive Range Springs

Heavy gauge Ni-Span C alloy, twin-spiral springs provide high sensitivity with lasting accuracy. Readily accessible . . . range changes are easily made, in minutes!



Unique Packless Drive

Eliminates stuffing box, torque tube, and bearings. Flexure-pivoted, bellows-sealed drive bar transmits diaphragm's linear motion to the pen arm with unequalled sensitivity *and undiminished* power. Seal for flexure pivot is a tough, flexible bellows.

MR. ENGINEER!...

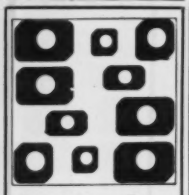
BURGESS

EXCLUSIVE WAFER CELL CONSTRUCTION

GIVES GREATEST SELECTION IN DRY BATTERIES

Whatever You Need in . . .

CAPACITY

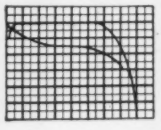


A correct cell-size for any capacity.

VOLTAGE

Wafer Cell construction produces from 1½ volts on up.

SERVICE



Burgess will make batteries to fit any application.

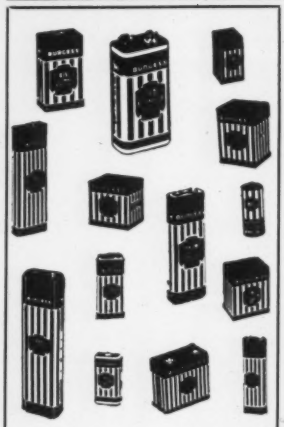
BURGESS

Has The Widest Choice of Dry Batteries Ever Manufactured . . .

The revolutionary Wafer Cell offers a 30% increase in battery life at *no increase in size.* This exclusive Burgess construction consists of a sandwich of manganese dioxide mix between two flat electrodes of zinc and carbon with spots of hot silver wax applied to each exposed pole of the cell, allowing perfect electrical contacts throughout and almost complete absence of vibration. Cells are wrapped in Mylar film and packed in such modern materials as aluminum for compactness, long shelf life, exceptional service life, outstanding dependability.

Burgess design specialists will work out the exact battery to fit your needs. Send your requirements to Dept. E57.

SIZES AND SHAPES



Wafer Cell construction can meet any space, size and weight requirements.

RESERVE BATTERIES

Can be stored dry for years. Activated only when immersed in water. No handling of dangerous electrolyte, no spilling or leaking. Wider range of efficient operating temperatures than any other type of battery.

BURGESS BATTERY COMPANY

FREEPORT, ILLINOIS

For more information circle **22** on inquiry card.

New York Stock Exchange:

Continued from page 2018

International Business Machine	376 1/2	278	291
International Tel. & Tel.	37 3/4	27	29 1/2
Lockheed Aircraft	57 1/8	26	33 3/4
Litton Industries	56 5/8	29 1/2	46
Magnavox	44	34	34 3/4
Minneapolis-Honeywell	131	73 1/2	87 1/2
Minnesota Mining & Mfg.	101	58	80 1/8
Motorola	51 3/4	35 3/4	44
Mallory P. R.	50 1/4	31	32 1/2
National Acme	80 1/2	44	45 - 46 1/2 (1)
National Cash Register	70 5/8	46 1/4	56 7/8
North American Aviation	39 1/4	20 1/8	26
Northrop Aircraft	26 1/8	18 5/8	21 1/2
Otis Elevator	49 1/2	39 1/8	42 3/8
Philco	18 3/8	12 1/2	12 7/8
Radio Corp. of America	40	28 1/4	31
Raytheon	23 3/4	16 3/8	19 1/4
Rheem Manufacturing	21 1/4	12	12 5/8
Robertshaw Fulton	36 1/2	25 5/8	28
Reliance Electric	50 7/8	36	37
Sangamo Electric	39 3/4	31 1/4	32 1/2
Sperry Rand	26 1/8	18	20
Square D	35 3/4	22 1/2	25 1/4
Standard Coil Products	9 3/8	6 1/2	6 7/8
Starrett (L.S.)	85 1/2	62 1/2	66 1/4 - 69 (2)
Stewart-Warner	41 5/8	31 5/8	33 1/2
Sylvania Electric	46 1/4	32 7/8	34 5/8
TelAutograph	8 3/4	5	5
Texas Instruments	31 1/2	15 7/8	24 1/8
Thompson Products	89 3/4	53 1/4	58 1/2
Tung-Sol Electric	37 1/2	24 1/8	27
Underwood Corp.	33 3/4	16 5/8	18 1/4
Union Carbide & Carbon	124 1/2	100	103 5/8
United Shoe Machinery	45 7/8	35	36 1/4
Western Union	20 3/8	15 5/8	15 7/8
Westinghouse Air Brake	33 1/8	21	21 7/8
Westinghouse Electric	63 5/8	52 3/8	58 5/8
Worthington Corp.	68 1/2	46 3/8	49

(1) Not traded - Bid - Asked
(2) Not traded - Bid - Asked

American Stock Exchange:

	Price Range for 1957 Thru 10/15 High	Low	Price As Of 10/15
American Meter	34 1/8	27 1/2	28 3/4 - 29 1/2 (1)
Aro Equipment	22 7/8	14 1/2	14 5/8
Belock Instrument	13 5/8	9	9 7/8
Benrus Watch	8 1/2	6 7/8	6 7/8
Breeze Corp.	8 3/8	5 1/4	5 5/8
Barry Controls "B"	12 3/4	5 1/2	6
Clark Controller	31	16 7/8	17 1/4
Clarostat Mfg.	5	3 3/8	3 1/2 - 3 3/4 (2)
Clary Corp.	4 7/8	3 1/4	3 7/8
DuMont Laboratories	6 1/8	4	3 7/8
Dynamics Corp. of America	7 5/8	3	3 5/8
Electronics Corp. of America	12 7/8	6	6 3/4
El-Tronics	3 7/8	1 7/8	2 1/8
Fairchild Camera & Instrument	27 3/8	16	21 3/4
Globe-Union	20 3/4	16 5/8	17 1/2 - 17 7/8 (3)
Hazeltine Corp.	44 1/2	29 3/4	35
International Resistance	6 1/8	4 1/8	4 3/8
Lear Inc.	8 3/4	5	5 1/2
National Research	26 5/8	15	16
Neptune Meter	33 1/2	23 1/8	24 1/8
New Haven Clock	9/16	1/4	1/4 - 5/16 (4)
Norden-Ketay	11 3/4	6 3/8	7
Nuclear Corp. of America "A"	2 1/4	3/4	1 1/2
Pneumatic Scale	25	19 1/2	19 - 20 1/2 (5)
Servo Corp. of America	8	4 5/8	5 1/2
Servomechanisms	12 5/8	6 1/8	7 7/8
Wallace & Tiernan	33 7/8	24 1/8	25 1/4
Waltham Prec. Inst. Co.	2 1/4	1 1/8	1 1/4

(1) Not Traded - Bid - Asked
(2) Not Traded - Bid - Asked
(3) Not Traded - Bid - Asked
(4) Not Traded - Bid - Asked
(5) Not Traded - Bid - Asked

Over-The-Counter

	Quotation As Of 10/15 Bid	Asked
Aerovox Corp.	3 1/2	4 1/4
Aircraft Radio Corp.	23 1/2	24 1/2
Argus Corp.	15 1/8	15 7/8
Eitel-McCullough Co.	25 1/2	27
Electronics Associates	34 1/2	37
Elox Corp. of Michigan "A"	7 3/4	9
Erie Resistor Corp.	8	8 3/4
G. M. Giannini	11 1/4	12 3/4
Liquidometer Corp.	5 1/4	6
W. L. Maxson	5	5 3/4
Penn Controls, Inc.	15 1/4	16 1/4
Speer Carbon, Inc.	24 1/4	25 1/2
Sprague Electric	22	24
Taylor Instrument	31	33 1/2
Telecomputing Corp.	2 5/8	3 3/8
Topp Industries	9 3/4	11
Varian Associates	13	14
Vitro Corp. of America	18	19

Amazing new performance in accelerometers

. . . with CEC's exclusive electrokinetic principle

Three self-generating, dynamic accelerometers for the measurement of accelerations from .01 g's to 1000 g's are now available from CEC. The exceptional performance characteristics of these accelerometers are made possible by the electrokinetic principle —forcing a polar liquid through a porous substance to create a potential difference between the surfaces of the substance.

Freedom from spurious resonances permits the accurate measurement of acceleration over a frequency spectrum extending to 80 KC. The low internal impedance, from 100K to 400K, permits operation without a high-impedance cathode follower. Operating over a temperature range from —20°F to +150°F, these accelerometers are undamaged by shocks of 5000 g's, and feature negligible response to transverse accelerations. For complete details, call your nearest CEC field office or write for Bulletins CEC 1600-X2, 1601-X2, and 1602-X2.

Subminiature Type 4-242-2 (shown at left) weighs 20 grams, and features a quick-disconnect cable. The Type 4-242-1 (flange mounting) weighs only 8 grams, including 18" attached cable. The Type 4-240-1 (pictured above) operates from 3 cps to 60 KC.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle **23** on inquiry card.

C/MAR

ANNOUNCES . . . NEW TAPOR-FLO* METER

A NEW DIMENSION IN FLOW MEASUREMENT

The C-Mar *Tapor-Flo* meter marks a new and significant advance in precision flow measurement . . . especially at low flow rates. It is an area-type flow meter whose outstanding performance characteristics are the result of modern production techniques.

Ultrasonic impact grinding shapes the flow orifice with exact reproducibility in glass or metal—permitting high guaranteed accuracies.

Precision bore tubing and close tolerances on the float (±0.003 in.) minimize friction.

The C-Mar Corporation now offers a number of practical meter designs for specific applications in research laboratories, pilot plants, industrial processes, and as components of original equipment. It will pay you to investigate the potential advantages of these new meters for your flow measuring problems. Write for literature today.

TAPOR-FLO METERS OFFER YOU THESE BENEFITS:

1. **Accurate Measurement of Low Flows:** Typical minimum range: 0.013 to 0.13 gpm of water with excellent readability even at lower end of evenly-graduated scale.
2. **High Stability of Float Position:** Float lines out quickly with minimum cycling. Holds position with high stability in the face of fluctuating line pressure.
3. **Linear Response to Flows:** Inherent linear response of float provides linear output signal in transmitter models. Ideally suited for use in ratio-flow control and data handling.
4. **Capacity Easily Changed Over Wide Limits:** Floats of different weights are easily changed in less than a minute. Maximum range can be up to six times minimum range.
5. **Simplified Installation and Maintenance:** *Tapor-Flo* design minimizes problems of installing and maintaining C-Mar meters.

C/MAR Corporation
TAPOR-FLO INSTRUMENTATION

35 Euclid Ave., Manasquan, N. J. • Phone: CAstle 3-0515

*U. S. AND FOREIGN PATENTS PENDING

For more information circle **24** on inquiry card.

OPERATING PRINCIPLE

Measured fluid (gas or liquid) enters bottom of meter, raising float A and opening a flow passage through tapered orifice B in side of tube C. Fluid flows through portion of orifice under float into outer tube and out top of meter.

For a given flow rate, float reaches stable position when pressure difference across orifice balances weight of float. Accurate shaping of orifice provides straight-line relationship between float position and rate of flow.

For laboratory applications, this glass model is a highly versatile flow indicator. Can be easily installed and maintained by inexperienced technicians. For pressures up to 80 psi and temperatures up to 150 F.

MB Series . . . Write for Bulletin 1010

For "in-line" installations, this rugged design has a heavy-duty glass jacket with metal body. Can handle pressures to 250 psi and temperatures to 150 F. Also available as flow transmitter for use with remote electronic recorder or recorder-controller.

MH Series . . . Write for Bulletin 2010

For pressures to 15,000 psi and 100 F maximum, this Type 316 stainless steel transmitter permits accurate measurement and control of smaller flow rates at high pressures. Used in combination with electronic recorder or recorder-controller.

DC-3 Series . . . Write for Bulletin 3010

For more information circle **24** on inquiry card.

MEASURE MICROVOLTS *without pre-amplification!*

with the New Du Mont type 403

$580.

FEATURING

AMPLIFIERS: Direct coupled amplifiers with single-ended or balanced input.

EXTREME SENSITIVITY: 5 millivolt to 500 volts full scale, continuously variable. Additional sensitivity for short term measurements, with resolution down to 20 microvolts.

FREQUENCY RANGE: DC to 300 KC.

Y AMPLIFIER CALIBRATION: 5%.

SWEEPS: 19 calibrated linear sweeps, 0.5 sec/cm to 0.5 usec/cm. Calibrating accuracy, 5%.

EXPANDED SWEEP: Any 10 cm portion of 50 cm sweep may be expanded 4 times and positioned on screen.

Price **$580.00**
Slightly higher in 50 cycle areas

TYPE 403R Rack mounted version, electrically identical to Type 403 $595.00

Complete Details On Request...

The Type 403 is the most sensitive oscilloscope commercially available. It permits direct measurements from low output transducers such as strain gages, pressure pickups, accelerometers, and others that normally require preamplifiers.

When used as a direct reading voltmeter, the Type 403 offers stability of better than 1 millivolt per hour for all ranges from 500 volts all the way down to 5 millivolts full scale. A super sensitive range is available of 1 millivolt full scale (100 microvolts per scale division) for short term measurements.

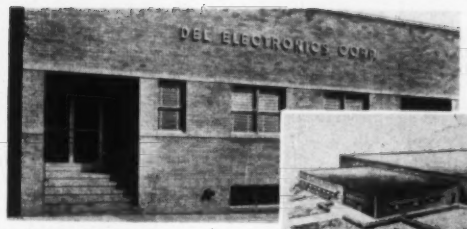
This outstanding performance is wrapped in the nicest package in the industry. The 403 features "human engineering" resulting in easier operation, complete accessibility and unsurpassed reliability backed by a 5-year guarantee.

ANOTHER OF THE 400 SERIES

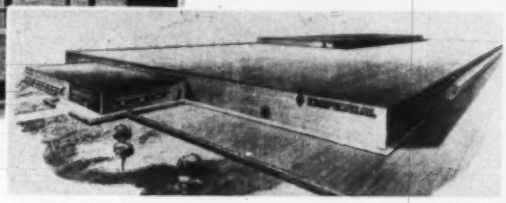
DU MONT

TECHNICAL SALES DEPARTMENT,
Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

For more information circle **25** on inquiry card.



Del Electronics' Mt. Vernon plant.



Imperial Brass' Niles, Ill., plant.

New Plants and Mergers

DEL ELECTRONICS has moved to a new two-story building at Mt. Vernon resulting in a five-time increase of its former production facilities.

IMPERIAL BRASS MFG. CO. has placed into operation a completely integrated tube fitting and tubing tool manufacturing facility at Niles, Ill.

AMERICAN MACHINE AND METALS, parent organization of **U. S. GAUGE**, has purchased Rahm Instruments, Inc., which will be operated as a separate division at the company's instrument plant at Sellersville, Penna.

FAIRCHILD CONTROLS' Components Div. at Hicksville, N. Y. announces expansion of facilities, making it a total of 50,000 sq ft.

RELTRON CORP. has recently been organized at 282 Centre St., Newton 58, Mass., to manufacture high temperature subminiature relays.

BENDIX AVIATION has purchased from the National-Standard Co. of Niles, Mich., its stock interest in Poroloy Equipment, Inc.

FARNSWORTH ELECTRONICS recently broke ground for a $3,000,000 manufacturing plant to be constructed in the Fort Wayne area. It will increase its production capacity by 100%.

SUPERIOR TUBE CO. broke ground for a new office building and mill addition at its general offices and main plant.

BECKMAN INSTRUMENTS announces acquisition of the outstanding stock of Arnold O. Beckman, Inc., which will be operated as a new branch.

VICTOREEN INSTRUMENT CO. has purchased assets, trade name and goodwill of JORDAN ELECTRONICS, INC.

MINNEAPOLIS-HONEYWELL, Industrial Div., has set up two new sales divisions, eastern and western, to keep pace with expansion of its Systems Engineering group.

EPLAB

Thermopiles

For many years the thermopile has been the accepted instrument for measuring Radiant Heat from Radiant Heaters at the American Gas Association Testing Laboratory in Cleveland, Ohio. Since 1930, when Vandaveer first described his work in this field,* an Eppley thermopile has been used for this purpose in hundreds of tests and the results have been consistent and accurate to within 1 per cent.

This is but one of many applications in the field of radiant energy measurements for which Eppley Thermopiles are ideally suited. They may be obtained with windows of different materials, and various types of black are available for receiver coatings.

All Eppley Thermopiles are supplied with a certificate of calibration, this calibration being made against a Standard Lamp from the National Bureau of Standards.

If you have a problem involving the measurement of radiant energy we invite you to write us, describing your problem in as much detail as possible. We will be glad to make recommendations and there will be no obligation.

*Vandaveer, Industrial & Engineering Chemistry, Vol. 22, page 596, June 1930.

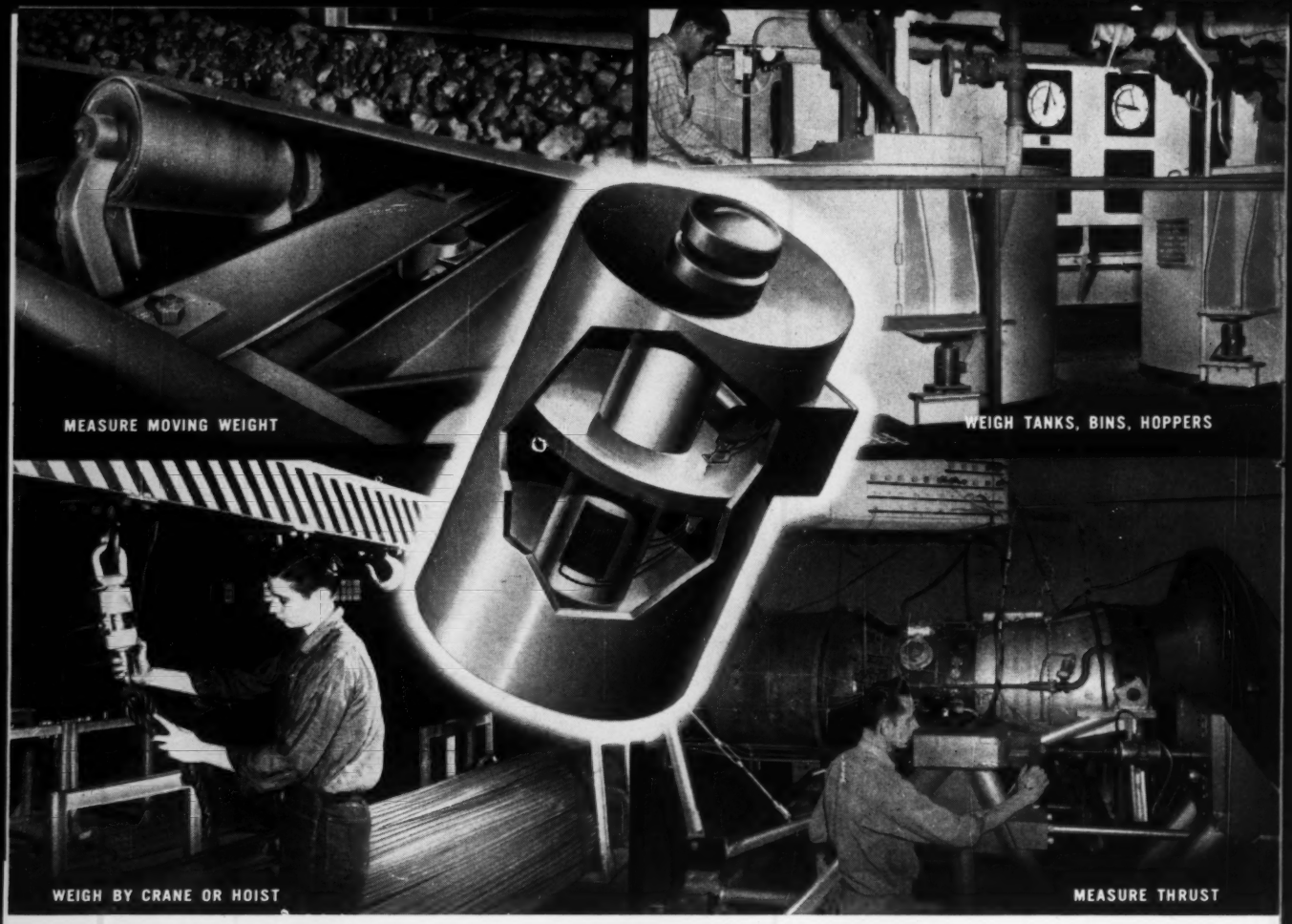
BULLETIN No. 3 ON REQUEST—Address: 2 Sheffield Ave., Newport, R. I.

THE EPPLEY LABORATORY, INC.

SCIENTIFIC INSTRUMENTS

NEWPORT, RHODE ISLAND, U. S. A.

For more information circle **26** on inquiry card.



SR-4® LOAD CELLS OFFER YOU NEW ACCURACY—EASE—ECONOMY IN ALL INDUSTRIAL WEIGHING AND PROCESSING

Baldwin SR-4 Load Cells end the costly task of moving loads to and from a weighing unit. Now weigh right in process! Compact Baldwin transducers will measure any tension or compression force—shaft or jet engine thrust—cable tension; determine center of gravity, weight and balance. The applications are virtually unlimited. Weigh loads at rest or in motion. Measurements are accurate to better than $\pm 1/4\%$; repeatability is better than $\pm 1/10\%$.

Standard Baldwin SR-4 Load Cells range in capacity from 50 to 200,000 lb. The varying electrical signal from the SR-4 Bonded Wire Strain Gage, basic component of the load cell, can be fed to a wide variety of Baldwin recording or computing equipment.

Whatever your weighing problem, a B-L-H representative can help you. For more information, write today for your free copy of Bulletin 4301 on SR-4 Load Cells.

BALDWIN · LIMA · HAMILTON

Electronics & Instrumentation Division

Waltham, Mass.

SR-4® strain gages • Transducers • Testing machines

For more information circle **27** on inquiry card.

ESC *corporation, first in custom-built delay lines,*

announces the opening of its new . . .

electronic components division

ESC®

pulse transformers

medium and low-power transformers

filters of all types

pulse-forming networks

miniature plug-in encapsulated circuit assemblies

exceptional employment opportunities
for engineers experienced in pulse techniques

ESC CORPORATION · 534 BERGEN BOULEVARD · PALISADES PARK, NEW JERSEY

For more information circle **28** on inquiry card.

People IN THE NEWS

H. I. Chambers

R. Rachals

R. E. Love

J. A. Tragard

W. F. Kamsler

C. A. Rowe

B. Jacobs

BECKMAN INSTRUMENTS announces appointment of *William F. Kamsler* as product line sales supervisor, Systems Div.

WALLACE & TIERNAN has appointed *Charles A. Rowe* manager of sales, Merchen Feeder Dept.

GENERAL TRANSISTOR CORP. has appointed *Dr. Bernard Jacobs* to newly created post of vice president in charge of research.

SEELYE STEVENSON VALUE & KNECHT, New York consulting engineers, recently acquired services of *Roger E. Marion.*

CONSOLIDATED ELECTRODYNAMICS CORP. has appointed *Herbert I. Chambers* chief development engineer.

KOLLMORGEN OPTICAL CORP. has named *Richard Rachals* vice president in charge of engineering.

WESTON ELECTRICAL INSTRUMENT CORP., subsidiary of Daystrom, Inc., has appointed *Richard E. Love* manager of recorders-controllers sales.

INDUSTRIAL NUCLEONICS' new contract operations Division is headed by *John A. Tragard,* war time chairman of the Industrial Instrument Industry National War Problems Committee. The new division was formed to negotiate government contracts for the company's products.

ELECTRONIC CONTROL SYSTEMS, affiliate of Stromberg Carlson Div. of General Dynamics Corp., has appointed *David E. Laughlin* as manager of the separate Marketing Section to handle the "Digimatic," tape controlled system for machine tools.

INTERNATIONAL RESISTANCE CO. has appointed *Felix T. Troilo* sales manager of its subsidiary, Circuit Instruments Inc.

CARL ZEISS

STEREO — MICROSCOPE

MADE IN WEST GERMANY

Uniform sharpness over the entire field of view. Erect, unreversed image. Outstanding plasticity; easy on the eyes, even during prolonged observation.

Novel rapid change of magnification from 6x to 160x with wide-angle oculars.

Large working distance from 3-3/4-inches, with diameter of object field up to 32mm. Beyond 80x magnification the working distance is 1-5/8-inch.

Write for literature

CARL ZEISS, INC., 485 Fifth Avenue, New York 17, N. Y.

Guaranteed uninterrupted repair service

For more information circle **29** on inquiry card.

Subminiature Hughes silicon power rectifiers pictured with some of the standard vacuum tubes they replace.

Body diameter: 0.105-inch max.
Body length: 0.265-inch max.

NEW, AT HUGHES
LOW-POWER RECTIFIERS WITH HIGH-VOLTAGE CAPABILITIES

Once again, Hughes has supplemented its line of silicon rectifiers—this time, with units rated up to 600 volts yet using the famous Hughes subminiature glass package. Like other Hughes rectifiers, these have the advantages of low forward voltage drop and low back leakage enabling them to handle power values that are large for the size of the rectifier. Features of this kind, combined with exceptional efficiency, make them ideal for electronic power supply applications where they can be used in place of many vacuum tube rectifiers.

Descriptive literature for the entire rectifier series is available upon request. Please write: SEMICONDUCTOR DIVISION • HUGHES PRODUCTS
International Airport Station, Los Angeles 45, California

SPECIFICATIONS

HR10311		
Peak Reverse Voltage (E_b) @ $-2\mu A$	I II III IIA IIIA IV	500V @ 25°C
Reverse Current (I_b) @ −450 Vdc		$35\mu A$ @ 150°C
Max. Ave. Inverse Current (I_{bv}) @ $315V_{rms}$ @ 200mA		$20\mu A$ @ 25°C
Max. Ave. Rectified Current (I_o)		200mA @ 25°C
HR10312		
Peak Reverse Voltage (E_b) @ $-2\mu A$	I II III IIA IIIA IV	600V @ 25°C
Reverse Current (I_b) @ −550 Vdc		$35\mu A$ @ 150°C
Max. Ave. Inverse Current (I_{bv}) @ $385V_{rms}$ @ 200mA		$20\mu A$ @ 25°C
Max. Ave. Rectified Current (I_o)		200mA @ 25°C

Maximum operating and storage temperature −65°C to +150°C
Derate average rectified current 1.5mA/°C above 25°C

The HR10311 and HR10312 have the famous glass package developed years ago at Hughes. This package, still the finest available, is tiny, but sturdy, thereby fulfilling all of the requirements for miniaturization while providing reliable operation under severe conditions of shock and vibration.

Creating a new world with ELECTRONICS

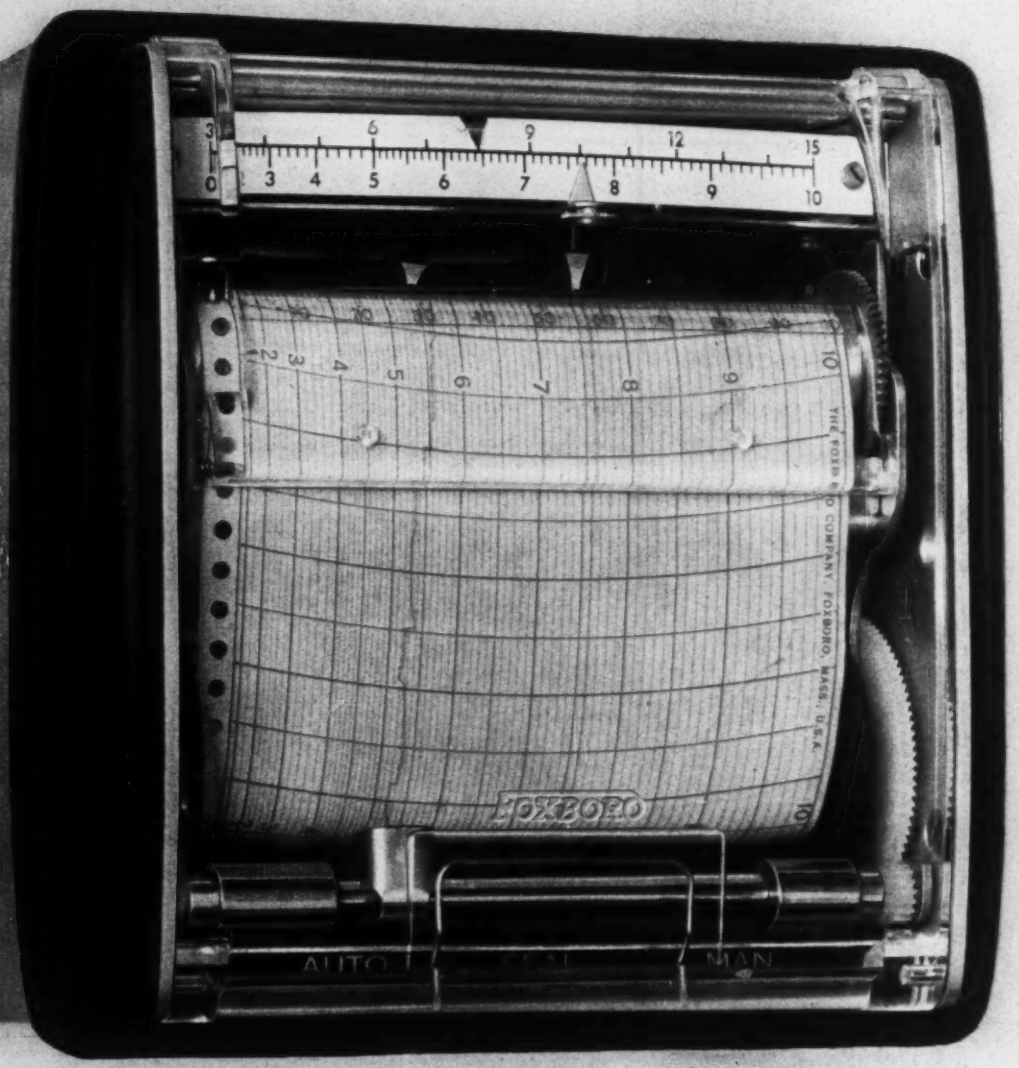
HUGHES PRODUCTS

HUGHES
SEMICONDUCTORS

© 1957, HUGHES AIRCRAFT COMPANY

For more information circle **30** on inquiry card.

FOXBORO
adds new convenience features to CONSOTROL* Recording Control Stations



Shown actual size

*Reg. U. S. Pat. Off.

– further "operating ease" combined with accuracy – readability – top performance

3-pen recording, angle mounting, indicating tear-off bar . . . just a few of the new convenience features you'll find in Foxboro Consotrol Recorders and Recording Control Stations.

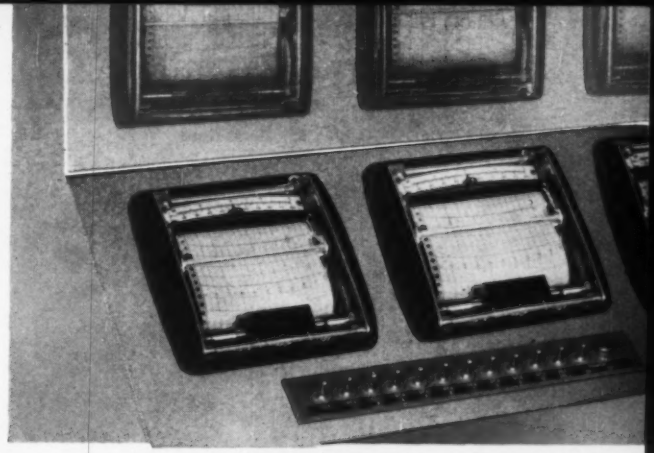
But these new operating benefits are only part of the story. Additional control functions are handled easily with Consotrol Instruments. Auto-Selector control — the control of related variables through a common valve is now possible with Consotrol small-case panel instrumentation, as is centralized control of batch processes.

With their new, exclusive operating conveniences and process control functions, Foxboro Consotrol Recording Control Stations, now, more than ever, provide you with superior centralized recording and control. You'll find they maintain the highest standards of precision and dependability — are the simplest to maintain.

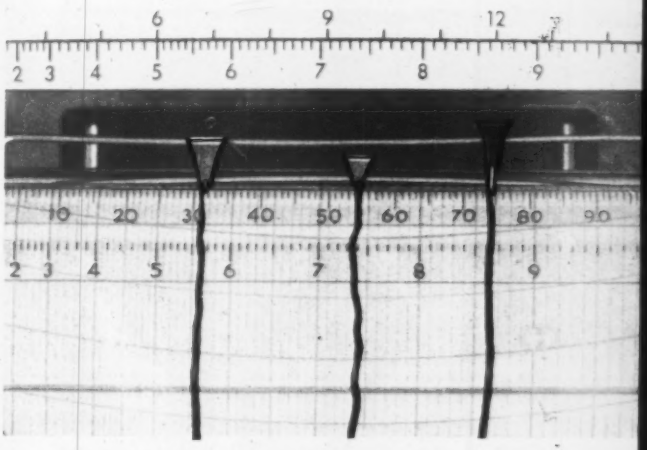
Write Foxboro for full details. Ask for Bulletin 13-18A. **The Foxboro Company, 4611 Norfolk St., Foxboro, Mass., U.S.A.**

FOXBORO

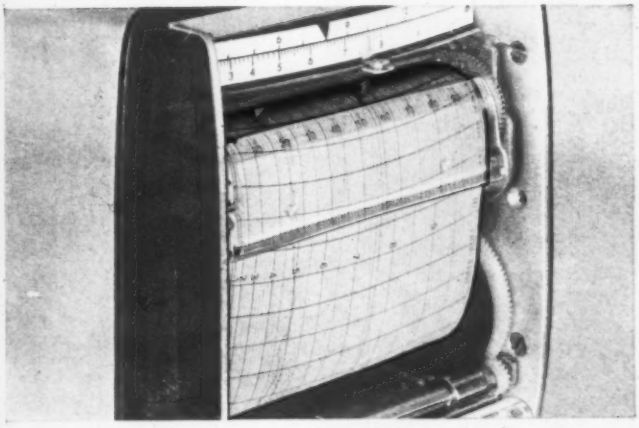
REG. U.S. PAT. OFF.



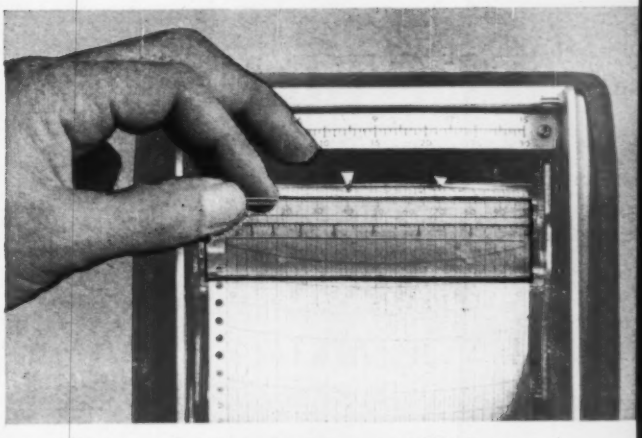
New – angle mounting Now you can panel-mount your Consotrol Recording Control Stations as much as 75° from the vertical, giving you more usable panel space closer to the floor. Operator can read lower instruments without stooping.



New – 3-pen recording 3 continuous records are simultaneously recorded on one chart, with this new Foxboro 3-pen recorder. Related measurements can be grouped for quick, easy comparison . . . valuable panel space is saved.



Full scale chart The Foxboro 4-inch Consotrol chart, with the same length scale as a 12-inch circular chart, travels vertically from the top. No sagging . . . no misalignment. Pen travels in same direction as circular-case recording pen.



New – indicating tear-off bar
Ideal for multi-pen control stations and recorders, this new "see-through" plastic tear-off bar has indicating scales to read second and third variables. Scale colors match pen colors – makes following a process a cinch for the operator.

For more information circle **31** on inquiry card.

THE THERMOELEMENT *simply plugs-in*

No need returning the Model 622 for thermoelement replacement; nor wiring a new one in. A spare element, or one immediately available for the individual instrument, can be instantly *plugged in*. Replacement units are furnished with correction curves to maintain the guaranteed high accuracy with original scale calibration. This is just one of several exclusive design features which make Model 622 more convenient, more flexible in use. And coupled with its *proved* high accuracy and stability, it remains the outstanding favorite for all high frequency problems. Available as thermo milliammeters and thermo voltmeters; and thermo ammeters, (external thermoelement type). Also as d-c voltmeters, millivoltmeters, milliammeters, microammeters, electrolysis volt-millivoltmeters, and as high accuracy rectifier type a-c instruments. Write for bulletin A20. Weston Electrical Instrument Corp., Newark 12, N.J.

WESTON

MODEL 622

portable

THERMO INSTRUMENTS

For more information circle **32** on inquiry card.

Wallace Electronics Faces an Economic Threat

Panhandle Pete

While Doc Alles, Director of Research of WESCO! is drawing pretty Systems Engineering pictures for his proposed new corporate structure for our company (while painting the East side of the factory at Long Bottom, W. Va., with a 4″ brush), and while our 141 engineers are out in the back yard cutting out the tin sheets and bolting them together for our 2½-stage Himmelrakets, Chief Engineer Bus 'Four-Card' Wallace and Salesmanager Waldo Klapsaddle, Jr. and I are relaxing over our afternoon game of Kriegspiel, played with our O. J. Computer (advertisement).

"Yes sir," says Bus, as he sneaked a look at Waldo's board, "We are nicely diversified with six completely unrelated products here at WESCO! —Aves analyzers, Air Filters, Par-Kometers, Ramps, Himmelrakets, and O. J. Computers—and all are selling nicely—except maybe the O. J."

"Now wait a minute, Cuz," says Waldo, who has a sharp eye for figures, including female. "Before you get too happy, have you thought about the income tax we will have to pay when the guvermint pays us the $4,789,642,386.51 for that gross of Himmelrakets now being assembled out back? It's a good thing that our company has a financial genius like me to keep you executives and engineers from getting too deep into financial problems like this—and I also have the solution. As soon as we get the check from the guvermint we will buy up about six or eight nice companies with red ink on their books. The red ink will cancel the black and, Q.E.D., no income tax."

"Waldo, that sounds good," says I, "But are you sure you have figured out all the angles? For one thing, won't our Director of Research spend all his time drawing up new corporate structure schemes and planning new systems subdivisions with all these new companies? And won't we also be buying several dozen more crackpo . . . er, I mean executives, along with those pretty engineers and nice red ink, and ain't we already losing enough on our O. J. computer division?"

At this Waldo ran off a fast calculation with his left hand on the O. J. computer without even missing one stroke on the YO-YO he was operating with his right hand—Waldo is a very versatile man—and within a minute he had the answer. "You can see here for yourself, Cuz, that our loss of $1,756,432.06 on the computer division won't even touch that Himmelraket income."

"And why are not our losses as large as other computer manufacturers," says I, recognizing the seriousness of this threat to our company future. "Can't we develop a few other models of the O. J.?"

"But we already have a mechanical, pneumatic, hydraulic, electrical and electronic version of the O. J., plus a vacuum-tube, gas tube, NPN transistor, PNP transistor, magnetic amplifier, solid state core, cryostatic and crystal amplifier type, plus an analog, digital, analog-digital, digital-analog, and analog-digital-analog model," replies Bus. "Of course next month's trade journals will probably reveal some basic new techniques—but so far we have used up all the techniques we know about."

"Bus, I am afraid that you are not acting as imaginative as a Chief Engineer should be," I points out. "What's the matter with atomic energy or cosmic rays? You could spend a fortune in either with a little ingenuity."

"If there wasn't a manpower shortage, we might do this, Pete," counters Bus, who knows all the answers. "As long as we need engineers on these development projects, our hands are tied. Maybe we could start a project to see if our computer could be used to develop another computer without any engineering labor or brainwork. Once this problem is solved we would never have any financial worries at all. The computer could develop the optimum number of other computer models, right up to the point where we would pay no taxes no matter how much money we made. Of course we could pay higher salaries and get as many engineers as we want."

At this point, Waldo leaned back in his chair and belched so loud that all the cats in a two-block area yowled. (Waldo is a bit uncouth!) "You know that is both unethical and against company policy—and it won't help us out this year. There must be some reason why these here other computer manufacturers are losing more money than we are year after year." Here Waldo emphasizes the point by whirling his YO-YO around his head, through his legs and up his back, without missing a stroke. "We have to meet the competition."

"Well one reason is publicity," says Bus, who isn't the country's leading Chief Engineer for nothing, "All of our competitors get lots of publicity. This leads to more applications than we get and each one is a good healthy loss. The more jobs they get, the more money they lose, the better financial shape they are in. It is really simple; the answer is publicity."

"Well let's get some more publicity ourselves," says I, "After all, I write for the country's leading magazine in the field."

"Shore, you're right, Cuz, it's all a matter of names," broke in Waldo, between strokes. "We bring out a new computer and call it an O. J.—our competitioners call them process-control Transmaculars, or computer-controllers or colitisiliacs or inverter-differentigrator-multiperplexers. Cuz, they get publicity clear up to their navels and what do we have? Nothin' but money. Say, do you suppose we could start a foreign office in some underdeveloped area of the world and really lose money in a big way? I wonder how Tibet or Siberia is as a market for Par-Kometers?"

"Let's not get impractical," says I. "We now have the solution. It's against our principles to pay our engineers more money but we can spend a fortune for Idea Men. Hire us a dozen of the most expensive promotion men you can find, Waldo, to re-name our entire line of products, then schedule twelve double-page advertisements in the most expensive magazines available, and we'll solve this problem in no time."

Panhandle Pete

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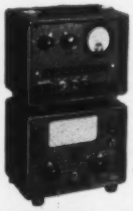

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SIGNIFICANCE

Our biography of significance this month tells about the type of man who has supervised the analog computation functions of an aircraft company. Frank Richmond is responsible for analog-digital computation development in a staff group working on systems and simulation at the Martin Company, Baltimore. He has been an active member of the Simulation Council, is well known throughout the field of analog computation, and has made basic contributions to the art of simulation. We are pleased to acknowledge Frank Richmond's important contributions, and to introduce him to you this month.

Biographies of significance

FRANK RICHMOND

Frank Richmond earned a B. S. degree in Physics from Roanoke College, Virginia, in 1935. He spent his first few years after graduation in radio servicing, broadcasting and sales (this happened to physicist's before World War II). During the war, he served as radio engineer (civilian) in Baltimore in 1942, and performed radar and fire-control electronics work with the Submarine Signal Company in Boston (1943-44). It was here that he first met computers—fire-control computers in this case.

After the war he worked for several years with Bendix Radio in remote control transmitting equipment, and then moved into missile-system control work for the Martin Company (in 1947), then called the Glenn L. Martin Company.

The year 1949 brought him into analog-computer simulation work at Martin. Analog simulation, although then only a few years old, was recognized as the most powerful way to design missile and aircraft systems; Frank's first job at Martin was to operate the analog computer. At that time the Martin Analog Simulation Section comprised REAC equipment (made for Navy by Reeves under Project Typhoon) with 40 amplifiers.

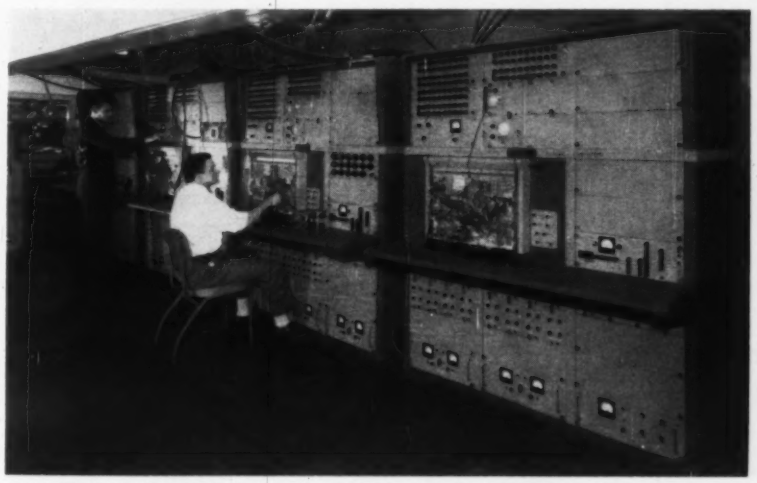
Today, less than 10 years later, the Simulation Section has 380 amplifiers, and more are coming!

Among Frank's professional achievements is a patent on an electronic integrator followed up by a patent application on a punch-card-controlled programmer for analog computers (of which Dave Nowack is co-inventor). The application has been accepted by the Patent office.

Frank has been active in the Simulation Councils since 1954. He knew Otis Updike, another active Council member, since high-school days when he represented Virginia in the Edison Scholarship Contest in 1929, in Coburn, Virginia, and also knew Floyd Nixon, who had been a charter member of the Western S/C. (Floyd is now Head of the Systems Department at Martin Orlando.)

Like most of the dedicated men now at work in analog computation, Frank believes that the technique is applicable to almost every phase of technical work, and he promotes his belief by teaching analog computation to Martin employees and Navy personnel in evening courses. Frank reads the S/C Newsletter in *INSTRUMENTS & AUTOMATION* monthly, and believes that this wide industrial distribution of the Simulation Council Newsletter has already done much to close the gap between analog computation and industrial application.

Frank and Hazel Richmond have been married since 1939, and enjoy their 2 boys and 1 girl, who in turn view their father's scoutmastering experience with great favor. Frank also holds a first-class commercial radio operator's license.



LATEST INSTALLATION at the Martin Analog Simulation Section is this REAC with servo-set pots and automatic punched-tape input and output.

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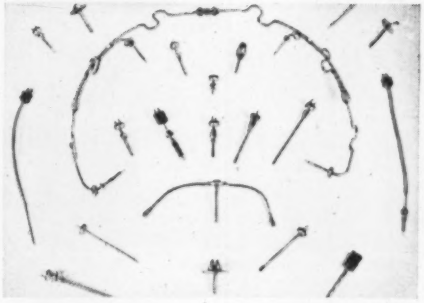

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[2] *Registered trademark Driver-Harris Co.*
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Richard Rimbach, Publisher

Sworn to and subscribed before me this 18th day of Sept., 1957. Kenneth M. Winterbottom, Notary Public. My commission expires Dec. 11, 1959.

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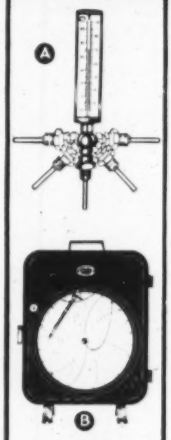

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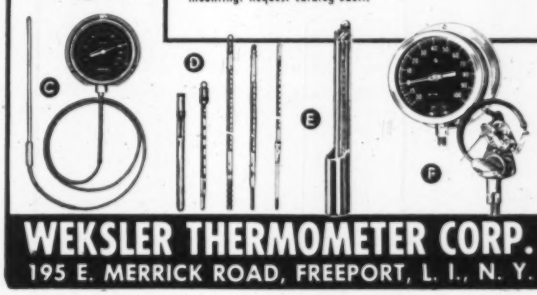

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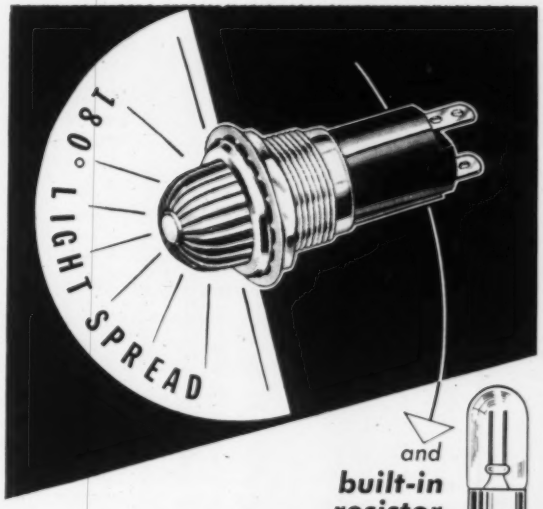

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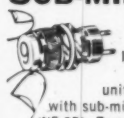

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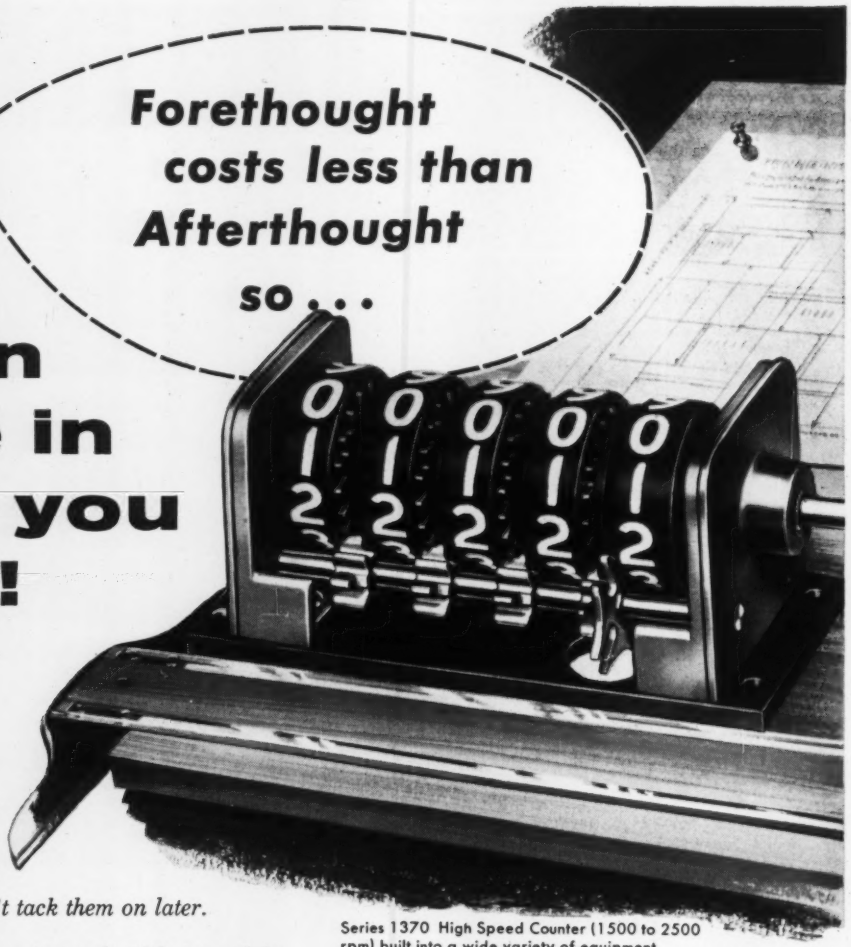

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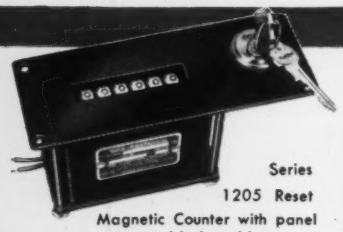

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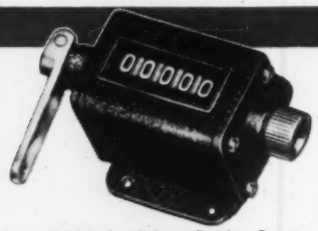

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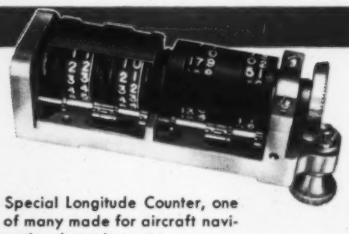

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Events

December 1-6

Annual Meeting of American Society of Mechanical Engineers, Hotels Statler, Sheraton McAlpin, New York, N. Y. For information write L. S. Dennegar, 29 West 39 St., New York, N. Y.

December 2-6

26th Exposition of Chemical Industries, New York Coliseum, New York. For information write E. K. Stevens, 480 Lexington Ave., New York 17, N. Y.

December 8-11

Eastern Joint Computer Conference, sponsored by IRE, AIEE and Assn. for Computing Machinery, Shoreham Hotel, Washington, D. C. For information write Morton M. Astrahan, IBM Corp., San Jose, Calif.

December 9-13

1957 (Seventh) Eastern Joint Computer Conference of the Institute of Radio Engineers, Association for Computing Machinery, American Institute of Electrical Engineers, Sheraton Park Hotel, Washington, D. C. For information write to Mr. Richard T. Burroughs, I.B.M. Corp., 1220 Nineteenth St., N.W., Washington, D. C.

January 30, 31, 1958

Seventh Annual Instrument Short Course co-sponsored by Southern California Meter Association and Los Angeles Harbor Junior College, at Los Angeles Harbor Junior College, Wilmington, Calif. For information write Thomas H. Ponton, 640 Fillmore St., Fillmore, Calif.

February 18

14th Annual Quality Control Clinic of Rochester Society for Quality Control, War Memorial, Rochester, N. Y.

March 17-21

1958 Trade show, atomic industry, International Amphitheatre in Chicago, Ill.

April 22-24

Electronic Components Conference, Ambassador Hotel—Los Angeles, Calif. For information write David M. Knox, Packard-Bell Electronics Corp., 12333 West Olympic Blvd., Los Angeles 64, Calif.

May 31-June 8, 1958

European Congress of Chemical Engineering and ACHEMA Congress,

Continued on page 2047

ONE HOOK CAN'T CATCH ALL FISH

One tape can't serve all recording needs in magnetic instrumentation

There are differences between pulse and carrier recording . . . therefore the tapes used in these systems must have different characteristics. Only in Soundcraft Instrumentation Tapes are these distinct and separate properties engineered into the oxide formulation. Soundcraft then adds two original processes — Uni-Level Coating and Micropolishing — to achieve the surface perfection found exclusively in the most advanced tapes of our time:

Soundcraft Type A Tape for Digital Recording

Soundcraft Type B Tape for Telemetering

Get the Soundcraft Tape that's made for your application . . . get error-free recording!

RCCH oxide formulation gives "Type A" higher signal output and greater retentivity plus unique surface hardness for controlled tape wear rather than uncontrolled equipment wear.

The special FM formulation in "Type B" is a highly refined form of gamma Fe_2O_3 oxide with high temperature binders, lubricants and anti-static agents to assure uniform speed and tape-to-head-contact — preventing flutter.

R14

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Brochure, Type A Tape ☐
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For more information circle **40** on inquiry card.

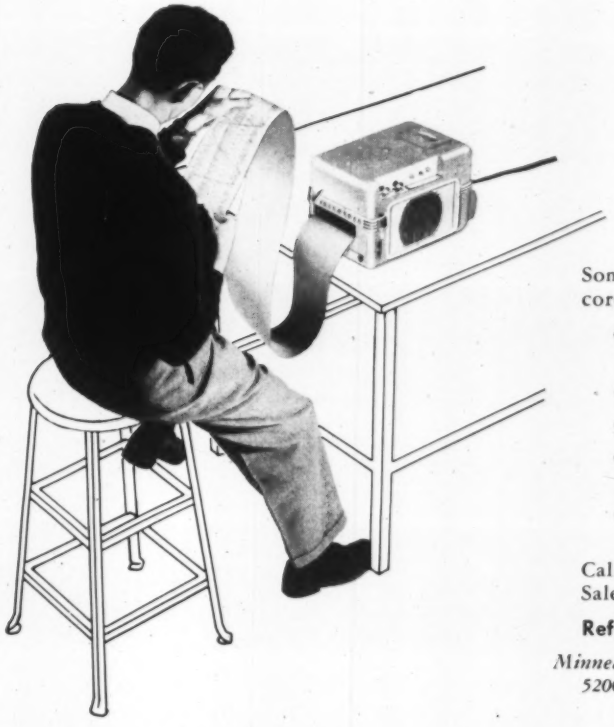
this is

This Visicorder Oscillograph record* is a symbol of the leadership that is typical of Honeywell engineering. In laboratories all over the world the Visicorder's instantly-readable direct records are showing the way to new advances in rocketry, control, computing, product design and component test and in nuclear research.

*reproduced actual size, unretouched

The Model 906 Visicorder is years ahead of the trend. It is the first oscillograph that combines the convenience of direct recording with the high frequencies and sensitivities of photographic-type instruments. The Visicorder alone among oscillographs lets you monitor high-speed variables as they go on the record.

a record of leadership



Some of the general features which give the Visicorder leadership in the direct-recording field are:

- Frequencies from DC to 2000 cps without peaked amplifiers or other compensation
- Six channels plus 2 timing traces on 6″ paper
- Deflection 6″ peak to peak; traces may overlap
- Record speeds 0.2, 1, 5, and 25 inches per second, minute, or hour
- Records require no liquids, powders, vapors, or other processing

Call your nearest Minneapolis-Honeywell Industrial Sales Office for a demonstration.

Reference Data: Write for Visicorder Bulletin

Minneapolis-Honeywell Regulator Co., Heiland Division, 5200 East Evans Avenue, Denver 22, Colorado.

MINNEAPOLIS
Honeywell

Heiland Division

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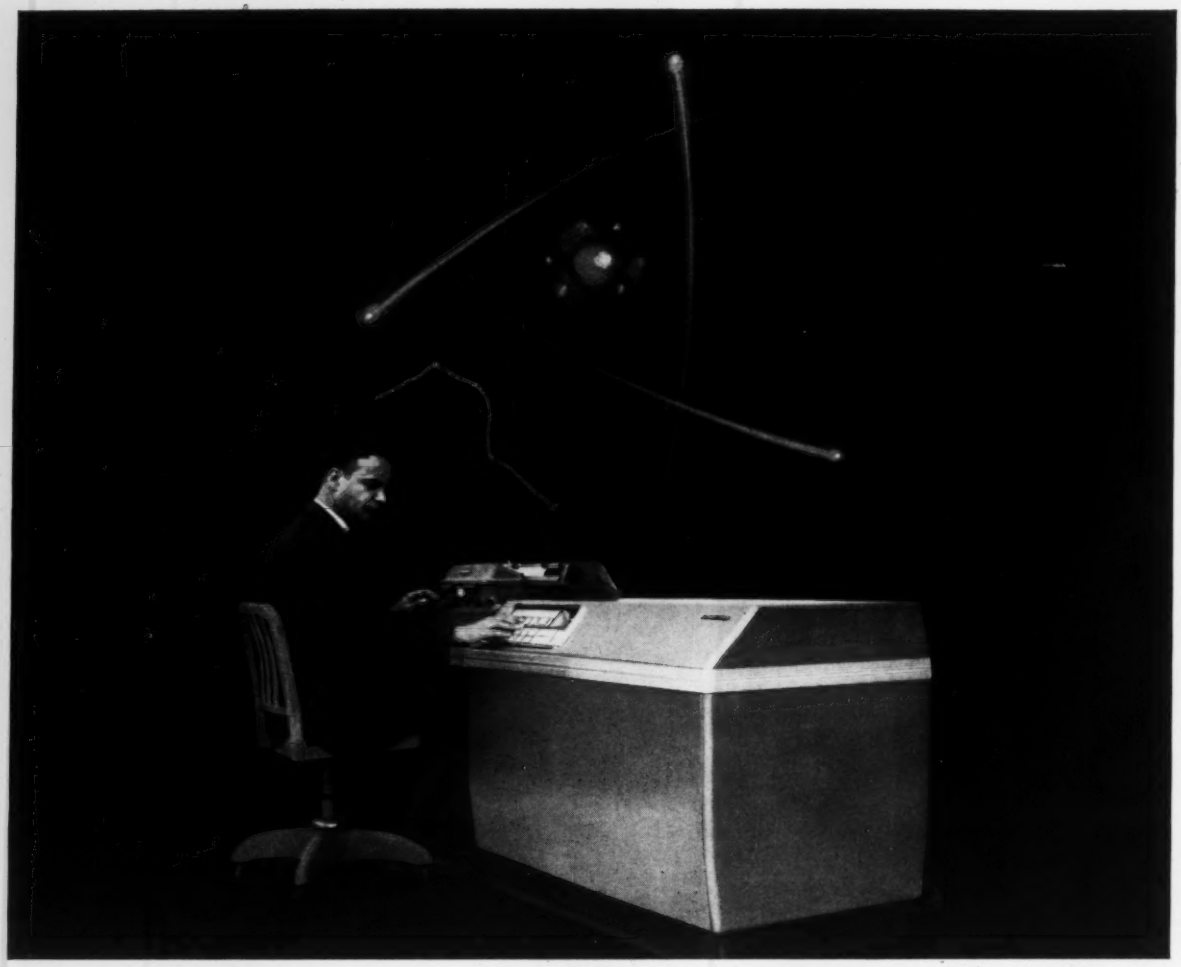

At last! A large-capacity electronic computer you use right at your desk! ROYAL PRECISION LGP-30

High-speed computation at the lowest cost ever for a complete computer system

No more waiting in line for those answers you need! No more lost time in executing preliminary calculations or modifying equations! Not with the LGP-30! Wheeled right to your desk, operated from a regular wall outlet, LGP-30 allows you to follow your work personally from beginning to end . . . to change formulae on the spot . . . to simulate optimum designs without weeks of mathematical analysis. Thus you get faster answers . . . added time for *creative* work.

Easy to use. LGP-30 is a general-purpose stored-program computer — internally binary, serial, single address. Just the few orders in the command structure give complete internal programming. Controls are so simplified, you get an "overnight" feel for your computer.

Unusual memory capacity. With a magnetic drum memory of 4096 words, LGP-30 is the most powerful computer of its size yet developed. Fully automatic, it executes self-modifying programs.

Exceptional versatility and value. Both the scope of LGP-30's applications and the range of calculations it can perform are almost limitless. It gives speed and memory equal to computers many times its size and cost, yet initial investment is the smallest ever for a complete computer. Maintenance costs are extremely low . . . service facilities available coast-to-coast.

Outstanding features of LGP-30

• Alpha-numeric input-output via electric typewriter or punched paper tape. • Optional input-output equipment available. • Unusually large memory — 4096 words. • Library of sub-routines . . . programs for wide variety of applications. • Mobile . . . no expensive installation . . . self-cooled. • Nation-wide sales and service.

For further information and specifications, write Royal McBee Corporation, Data Processing Equipment Division, Port Chester, N. Y.

ROYAL McBEE

WORLD'S LARGEST MANUFACTURER OF TYPEWRITERS AND MAKER OF DATA PROCESSING EQUIPMENT

For more information circle **42** on inquiry card.

EVENTS —CONTINUED

Frankfurt a.m., Germany. For information write DECHEMA, Dechema-Haus, Rheingau-Allee 25, Frankfurt a.m., West Germany.

June 9-13, 1958

Fourth International Automation Exposition, Congress, Conferences, and Clinics, New York Coliseum. For information write Richard Rimbach Associates, 845 Ridge Ave., Pittsburgh 12, Pa.

June 23-27

12th technical Photographic Exhibit in conjunction with 61st Annual Meeting and 13th Exhibit of Scientific and Testing Apparatus and Laboratory Supplies sponsored by The American Society for Testing Materials, Hotel Statler, Boston, Mass. For information contact E. W. Walsh, Chairman, ASTM Photographic Exhibit, The Narragansett Electric Co., 15 Westminster St., Providence, Rhode Island, *or* the Headquarters of the American Society for Testing Materials, 1916 Race St., Phila. 3, Pa.

August 5, 6 and 7

1958 Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers of The American Institute of Electrical Engineers (AIEE), Hotel Statler, Los Angeles, Calif. For information write to G. C. Anderson, Autonetics Dept. 388-64, 9150 E. Imperial Hwy., Downey, Calif.

if You

manufacture automation, instrumentation or automatic control components, devices or systems . . . exhibit at the

FOURTH INTERNATIONAL
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EXPOSITION and CONGRESS

NEW YORK COLISEUM JUNE 9 to 13, 1958

For descriptive brochure and list of products successfully exhibited at previous Automation Shows, contact

RICHARD RIMBACH ASSOCIATES, Mgmt.
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FIRST AND ONLY...

MINIATURE TWO PEN 5" RECORDING POTENTIOMETER

Transistor Amplifiers

exclusive from...

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$1195.00*

THE ULTIMATE IN AN ACCURATE, READABLE, MINIATURE RECORDING POTENTIOMETER, WITH THESE ADVANCED FEATURES

- 5-inch strip chart record.
- Two pens, each traveling the full 5 inches.
- 1-second maximum balancing time.
- Table top or panel mounting.
- Panel space 9⅝" W x 8½" H
- Margin marker pens.
- Paper supply indicator front of recorder.
- Ball bearings in pen drive system.
- New concept in front set limit switches.
- 0.5% accuracy on both pens.
- Completely transistorized amplifiers, no vacuum tubes.
- MV or TC Calibration
- Minimum Span: 1 MV
- Standardization: Mercury cell.
- Simple sub-assembly type construction for easy maintenance. (Entire recorder rolls forward out of case.)

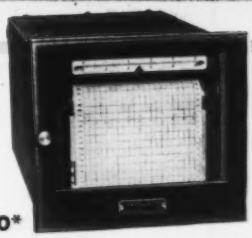
PLUS THESE OPTIONAL FEATURES:

- One front set SPDT switch and 3 SPDT back set switches each independently adjustable over the entire range on each pen.
- Transmitting slidewires.
- Selsyn motor chart drive.
- 3 speed quick change chart drive.
- Left and/or right margin marking pens.

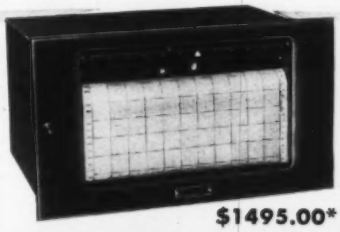
WESTRONICS RECORDING POTENTIOMETERS FOR EVERY NEED

One Pen Miniature 5" Recording Potentiometer

- 5" strip chart record.
- Continuous Automatic Standardization with electron tube amplifiers.
- Requires only 9⅝" by 8½" panel space.
- Accuracy better than 0.5%.
- One second full scale pen travel.
- Weighs less than 25 pounds.



$490.00*



Two Pen 11" Recording Potentiometer

- 11" strip chart recorder (12" overall width).
- Completely transistorized amplifiers.
- Reduced maintenance.
- Small size.
- Immediate recording . . . no warm-up time.
- Optional synchronous motor or Selsyn motor chart drive.

$1495.00*

***BASE PRICE**

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Here is Why!

You can dispense with oil filters and dust filters when you install ®Nash® Clean Air Compressors. You can save the cost of maintaining these devices. You can greatly reduce instrument maintenance costs. For the Nash employs no internal lubrication, therefore no troublesome oil is in the delivered air. Moreover, air from a Nash is thoroughly washed and cooled as it passes thru the pump. Dust in the plant atmosphere, even fly ash, is immediately removed.

®Nash® Clean Air Compressors are simple, with only one moving element. No valves, gears, pistons, sliding vanes, or other enemies of long life and constant performance complicate a Nash. No aftercoolers are needed. You will find it profitable to investigate these pumps, now.

No oil filters.
No dust filters.
No internal lubrication to contaminate air handled.
No internal wearing parts.
No valves, pistons, or vanes.
Non-pulsating pressure.
Original performance constant over a long pump life.
Low maintenance cost.

NASH ENGINEERING COMPANY
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TI announces DATA GAGE*

Remote Liquid Level Measurement System

The DATA-GAGE is the direct product of Texas Instruments working closely with the engineers of a leading oil company. The result is the first transistorized automatic tank gauge that gives you *triple-check* reliability, dependable Power Float accuracy to 1/16 inch, low maintenance, operational simplicity, and 100-tank capacity in ONE LOW COST SYSTEM!

Eliminates Costly Errors—DATA-GAGE does not depend on alertness of operator to catch errors. System *automatically triple-checks* itself for accuracy before any data is displayed: 1. Operational check of Power Float; 2. Identification of tank connection; 3. Telemetering check for correctness and completeness of data.

Dependable Accuracy Under All Conditions—1/16 inch accuracy at depths of zero to 64 feet. No need to recalibrate over a wide range of liquids, temperatures and specific gravities. DATA-GAGE is the *only* system to give reliable readings during blending turbulence.

Low Initial and Long-range Cost—DATA-GAGE is a complete measurement system requiring no expensive extras. No special transmission system or conduits are required at installation—often existing ground level gauge connections and pipes can be utilized. Transistors are used instead of short-lived vacuum tubes. Easy access and quick-disconnect parts in all units make this the easiest to service of all systems.

Operational Simplicity—operator simply dials tank number and awaits data to be displayed seconds later on the exclusive DataFLASH reading panel. He need not make comparative readings to determine errors—DATA-GAGE automatically checks itself.

Power Float Reliability—the mechanical surface finder is a moving rather than static float, registers the instant surface tension is broken. No possibility of tilting, locking or sticking and giving an erroneous reading.

Proved Telemetering—true digital system employs digital code in binary decimal form. Means of transmission is a completely redundant (code group and its complement are transmitted), three-state code, the reliability of which has been thoroughly proved in transatlantic telegraphy.

Utmost Safety Precautions—field units are plug-in type which may be removed to safe area for servicing. No electric wires enter the tank. Explosion-proof housings are available on all field units.

For complete detailed information on the modern DATA-GAGE system, write for Bulletin No. M-601.

TEXAS INSTRUMENTS INCORPORATED

INDUSTRIAL INSTRUMENTATION DIVISION

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*TRADEMARK REGISTRATION APPLIED FOR.

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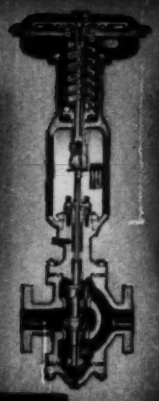

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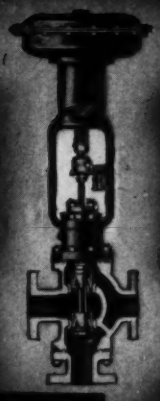

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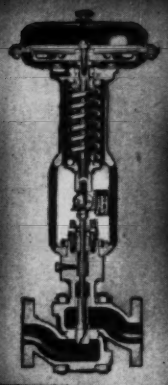

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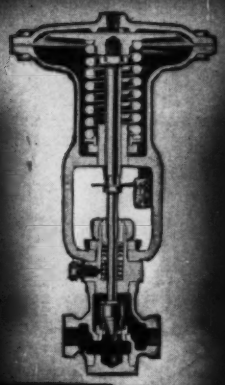

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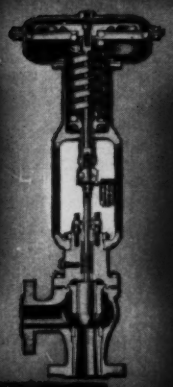

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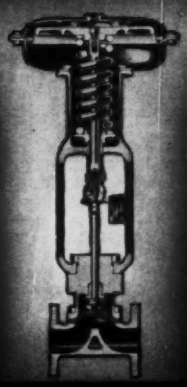

TYPE 657–SAUNDERS

FISHER®

Has the control valve for your plant

Special design bodies for process services

Wide selection of sizes and available in all castable alloys

Supplied with improved diaphragm operator that provides accurate valve response

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CANADIAN PLANT: WOODSTOCK, ONTARIO

LEADS THE INDUSTRY BY RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

The state of the art of

Bellows

is changing

In the past few years, improvements in design and performance of welded diaphragm type metal bellows have made a substantial contribution toward better overall performance of many components and accessories for aircraft and industrial use. In many cases, cost has been reduced because of savings in assembly at the purchaser's plant, plus elimination of special processing formerly used to insure clean, leak tight assemblies.

These improvements are the result of advances in (a) mathematical analysis of stress concentrations and distribution in new diaphragm contours, (b) testing and evaluation processes and equipment, (c) manufacturing controls. An exacting analysis of contour with respect to pressure and deflection stresses, is an extremely complicated process. Nevertheless, stress analysis is a fundamental part of bellows design and since it actually represents the limiting factor governing precise movement and life expectancy, rapid and accurate means for its measurement are most desirable. From the mass of analytical studies on hand, plus empirical data, parameters have been established and plotted, reducing the time for this work to a reasonable amount.

Testing of bellows falls into two groups—life cycling under simulated operating conditions, and measurement of physical characteristics. Life tests are run under conditions of pressure, stroke, temperature, vibration etc.

Physical characteristics include spring rate, hysteresis, drift, effective area and deflection per unit pressure. For sensitive bellows, (low spring rate) special test procedures have been developed for the measurement of these characteristics. The accuracy of the measuring equipment itself is of prime importance and for sensitive work is in the order of .2%. Manufacturing processes are proprietary but the results are not. Production bellows are being held to spring rates of ±5% and effective areas of ±1%.

The advances mentioned above have practical value and make possible bellows with the following attributes:

- excellent spring characteristics and pressure deflection curves
- consistently long life under operating conditions from 10,000 to over 1,000,000 cycles
- pressure ranges from vacuum, to as high as 7,000 PSI for a bellows of 2.60" outside diameter
- large volumetric expansion for small free length, (for example, .90" diameter bellows .06" high will displace .8CC)
- elimination of outgassing in evacuated and sealed systems resulting in long operational and shelf life
- leak tight assemblies to 10^{-10} std. CC/sec. leak rate
- heat resistant assemblies to temperature ranges limited only by choice of material
- corrosion resistant assemblies governed by choice of material
- weight savings resulting from end plate design and incorporation of features usually extraneous to bellows

Proved Applications:

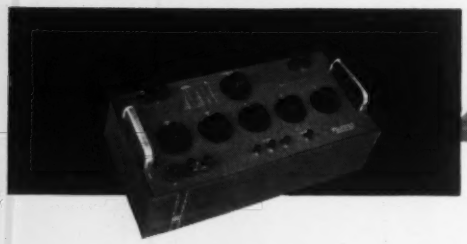
	Elimination of outgassing	Leak tightness	Heat resistance	Corrosion resistance	Spring characteristics	Pressure-deflection characteristics	Sensitivity, low spring rate	High pressure	Large volumetric displacement	Light weight	Long life
Volume Compensators; gyros, accelerometers, Instruments	X	X			X				X	X	
Force balanced systems; auto pilots, fuel controls, control mechanisms	X	X			X	X	X			X	X
Instrument capsules; DP cells,	X	X	X	X	X	X	X	X			
Pressure switches, pressure gauges		X	X	X	X	X	X	X			X
Valve stem seals, rotary shaft seals		X	X	X				X			X
Flexible connectors; expansion joints, ducting, piping		X	X	X				X		X	X

METAL Bellows CORPORATION

29 Mica Lane, Wellesley Hills 82, Massachusetts

For more information circle **178** on inquiry card.

← Circle **45** on inquiry card.



4735

L&N's new Guarded Wheatstone Bridge

If you are checking resistors, making routine resistance measurements, or performing laboratory experiments, this new 4735 Guarded Wheatstone Bridge gives you faster, more accurate resistance measurements.

The most advanced general purpose bridge available today, this new 4735 has a host of new features including: high accuracy with a wide operating range . . . guarding of galvanometer circuit to prevent voltage errors due to humidity effects . . . three galvanometer keys interlocked with a battery key . . . thermals minimized by special features of construction . . . and bench-type or relay-rack mounting.

Complete information on this versatile bridge is presented in Data Sheet E-53(1). Write today for a copy from your nearest L&N Office or from Leeds & Northrup Company, 4955 Stenton Ave., Philadelphia 44, Pa.

Partial Specifications

List Number—*4735 Guarded Wheatstone Bridge.*

Range—*0.01 ohm to 1,111 megohms.*

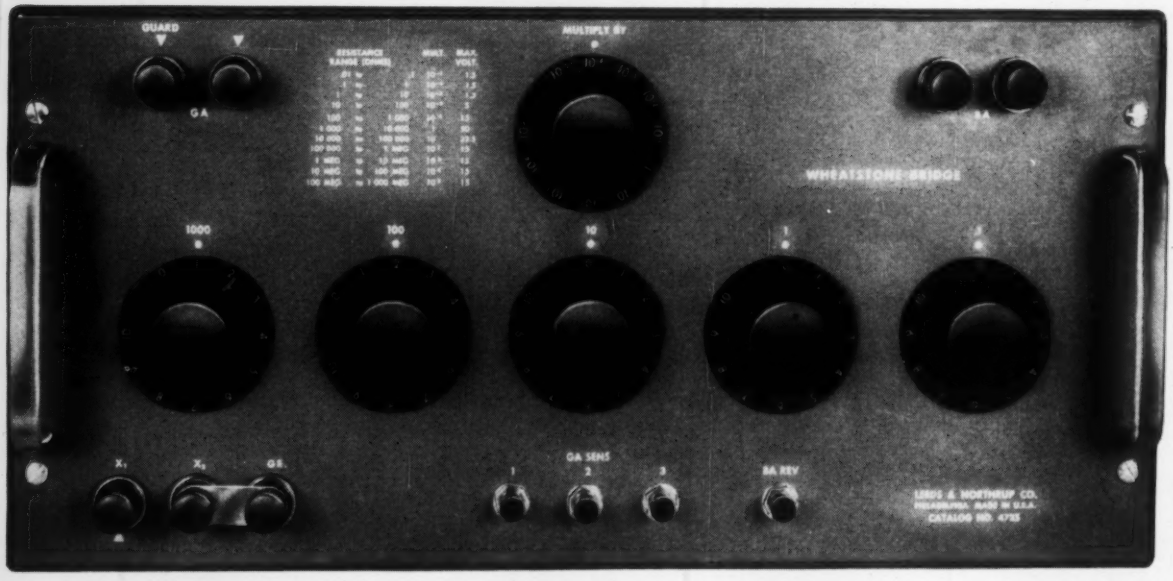
Limit of Error—*±(0.05% + 0.001 ohm) up to 100 megohms; ±0.5% above 100 megohms.*

Rheostat Switches—*Five decades of enclosed switches in steps of 10 x (1000 + 100 + 10 + 1 + 0.1).*

Multiplier Dial—*Eleven-position enclosed switch; from 10^{-5} to 10^{+5}.*

Galvanometer Sensitivity Keys — *Three tap keys provide sensitivities of approximately 1, 1/100 and 1/1000. Battery reversal key is provided.*

Case—*Metal, gray enamel finish; 19" x 9" x 7", for relay-rack or bench use.*



Guarding against effects of humidity
High accuracy with wide operating range
Fast reading of resistance values

LEEDS & NORTHRUP
Instruments
Automatic Controls • Furnaces

For more information circle **46** on inquiry card.

Pittsburgh's Answer to Sputnik

Editorial

SPUTNIK and Muttnik have caused alarmed reactions at all levels of our national life. These reactions range from a hysterical "our way of life appears inadequate to counter that of the communist" and a determined "we must immediately embark on a national crash program on the Manhattan Project scale in order to regain the lead in missiles and rocketry," to a fundamental "we must rejuvenate our interest in science."

There is no reason for hysteria. Russia did not abandon Communism when the United States led in the development of atomic weapons, and the United States should not abandon democratic capitalism when the Russians lead in rocketry. Most of the cities of the world have been lying under the threat of total devastation for at least 5 years—the threat can become no greater than total. The military implications of satellites are no different from those of advanced bases with medium-range nuclear-warheaded missiles. Most of the cities of the world are in that range today and have been there for years.

The success of the Russians is due in large part to their development of technical education for a generation. What has happened in America is precisely what educators have been trying to tell the government and the citizenry—without success—for two full decades. It is simply that the combination of poor teachers' pay and poor laboratory facilities at the high-school level particularly (and at all other levels also), will result first in a deficiency of scientific and engineering teachers and students and later in a deficiency of scientific and engineering workers.

This idea, after being repeated in about a hundred national conferences and committee meetings, died a natural death when the federal government consistently declined to aid education via a federal program. The not surprising result is that another nation has surpassed the U. S. in one field of technology—rocketry—and is in strong position to achieve superiority in other fields.

Those who killed the federal aid-to-education program are now loudest in their demands for a "revitalization of technical education." Unfortunately, revitalization of education in any field is not accomplished by Presidential talks on national TV hookups, or by still more conferences and symposia on the subject. The laboratory facilities of the high schools of America are a disgrace; they were out of date twenty years ago and haven't changed since. The average high-school math-science major knows little or nothing of electronics, instrumentation, automation, computation, binary techniques, industrial equipment, recorders, or any of the exciting developments of the last ten years. And the hard facts are (1) high schools of America supply the college students, and (2) the high schools of America have not maintained their technical responsibilities, resulting in decreased attraction of students to all technical professions. There is a shortage of technical personnel at all levels—technicians, engineers, scientists, teachers. Hence the dwindling number of teachers are bought away from their profession by engineer-hungry industry; engineers are used to perform duties that should go to technicians; students who should become technicians become truck drivers at higher pay; scientists find themselves without adequate staff at all levels; basic research is neglected in favor of applied research on immediate problems.

The saddest part of this picture is the fact that no amount of money will buy us out of this situation; no crash program can completely overcome a generation of neglect, although it will help.

As long as the federal government—and the citizenry—refuse to acknowledge the fundamental importance of up-to-date and dynamic high-school laboratory facilities, of the essentiality of proper motivation and indoctrination of students at the high-school level, the job must be done piecewise, at the local level.

This job is being done in the nation's first authorized public-high-school course in automation, elec-

WALTER STANCATI, District Manager of the Foxboro Co., demonstrates the Foxboro Dynalog recorder to the class.

ADRIAN PHILLIPS, developer of the Loewy-Hydropress automatic tubing-mill-product gager-inspector-weigher-marker develops the principles, operation, need, and application of the equipment.

tronics, and instrumentation, now underway in Pittsburgh, Pa. Its objectives are (1) to motivate the student by familiarizing him with modern equipments for industrial and research operations, and (2) to show how basic principles of physics and chemistry are applied through instruments to probe nature's secrets and to perform mankind's work. Its objectives can be stated also as (1) to increase the interest of students in basic science and modern technology, including instrumentation, industrial chemistry, and electronics, (2) to induce students to go to college to become superior workers in the fields of engineering and science of their choice, (3) to train students for positions as technicians, junior engineers, senior engineers or scientists, depending on their future aptitudes and opportunities.

The Pittsburgh school authorities selected the outstanding math-science-major high-school seniors from more than 400 applicants for the course. The students —from all the high schools in the city—must travel many miles to spend ½ day—every day—in the one school where the course is being given; then they must travel back to their home school. The course is *in addition* to their normal high-school schedule; the students take their regular physics, chemistry and math in order to meet college-entrance requirements.

The course now has been underway for two full months, and here is a report on its progress to date.

Report on First Two Months of School Program

In the first two months of the course, the students have studied basic electrical movements, and have converted the permanent-magnet moving-coil movement into ammeters, voltmeters, and ohmmeters. They then have used the instruments to measure currents and voltages in series and parallel circuits.

The time constant of *R-C* and *R-L* circuits have been studied. Phase relations, and impedance of *R-C-L* circuits have been investigated.

The voltage-current relations in bridge circuits have been investigated very carefully.

Digital arithmetic and binary codes have been taught. All numbering and many problems throughout the course are being done in binary so that the students are learning binary arithmetic—addition, subtraction, division.

Brief review of primary elements for temperature and pressure has been given as an introduction to the study of recorders. (Measurement of temperature, pressure, flow, quality, composition, etc., is scheduled for later months.)

Recorders have been demonstrated, worked on, and observed in operation, including potentiometer recorders, oscillographs, high-speed photographic recorders etc. (see illustrations).

An automatic device for gaging, inspecting and marking tubing-mill products has been demonstrated and discussed (see illustrations).

Electron tubes have been studied, with the students making characteristic curves of tube operation.

The present phase of the program, now entering its third month, is on pneumatic control. The air supply has been studied, and controllers of various manufacture are now being demonstrated and explained.

The average week consists of two or three demonstrations of equipment conducted by local representatives of the equipment, bench work on the electronics and principles of these equipments, and a test each day.

ALL THIS HAS BEEN DONE IN THE FIRST TWO MONTHS, AND NOT EVEN A FLU EPIDEMIC AND A STREET-CAR AND BUS STRIKE HAS KEPT THE STUDENTS FROM REACHING THIS CLASS.

EDMUND WINSTEL JR., Service Engineer, demonstrates the Bristol Dynamaster recorder.

Texts Selected

The teacher has selected three basic text books for use throughout the course—and makes extensive use of manufacturers' literature on the specific equipments under study. The books are *Electronic Circuitry for Instruments and Equipment* by M. Aronson; *Digital Techniques for Computation and Control* by Klein, Morgan and Aronson; the *Handbook of Measurement and Control* by Behar. The circuitry book has proved excellent as an introduction to electronics; the *Digital* book for binary codes; the *Handbook* for specific measurement aspects.

Support Given

The course is being guided by a committee of consultants from industry. The committee has developed the support of several local technical societies that are now planning and conducting specific phases of the course. These include the *local chapters* of the Instrument Society of America, the Spectroscopy Society of Pittsburgh, the National Machine Accountants Association, the American Society for Quality Control, the Society of Corrosion Engineers, the Society of Automotive Engineers, and the Society for Non-destructive Testing—all of whom have given or pledged financial or technical assistance.

The word "local" is emphasized in the preceding paragraph because expected support from the richer and more powerful national organizations of these local societies (and indeed from even the larger local societies) was not forthcoming. Hence, this program can be considered as purely local in its support, and the many other cities and school boards who are watching this program may conclude that support must be found locally. Perhaps this is a desirable development; the program is succeeding without dependence on any national foundation.

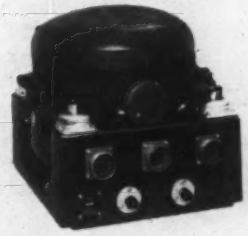
The technical support given by the local societies is exemplified by the phase of the program being handled by the Spectroscopy Society. It includes a movie, "The Spectrograph," a field trip, and experiments, on x-ray diffraction, emission spectroscopy, spectrophotometry, infrared, spectroscopy and mass spectrometry. The other societies are arranging similar programs in their fields of specialty.

The power of this program should be evident from the description of the course above. The teacher and all the students are filled with enthusiasm for the entire program. As has been mentioned, not even an epidemic and a transportation strike have kept the students from the classes, which require much daily travel on the part of each student.

Periodic reports on this class will be given here in the future.

PERFORMANCE PROVES CAPABILITY

INERTIAL GUIDANCE



KEARFOTT has been engaged in the development, production and flight testing of Inertial Systems and their components for over 7 years. Their leadership in the field of lightweight, high precision Inertial Guidance Systems for aircraft and missiles has been proved by performance. The instrument shown here is a typical KEARFOTT inertial platform.

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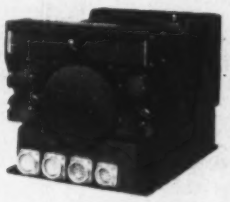

Based on a 29.5 pound 3 gyro, 4 gimbal platform, Kearfott All Attitude Compass Systems provide continuous steering signals throughout a LABS maneuver. In addition to the compass features of the U.S.A.F. J4 System, precise vertical reference for fire control, autopilot and radar stabilization is available. Proved by 2 years' service in the field. Total system weight—57 pounds.

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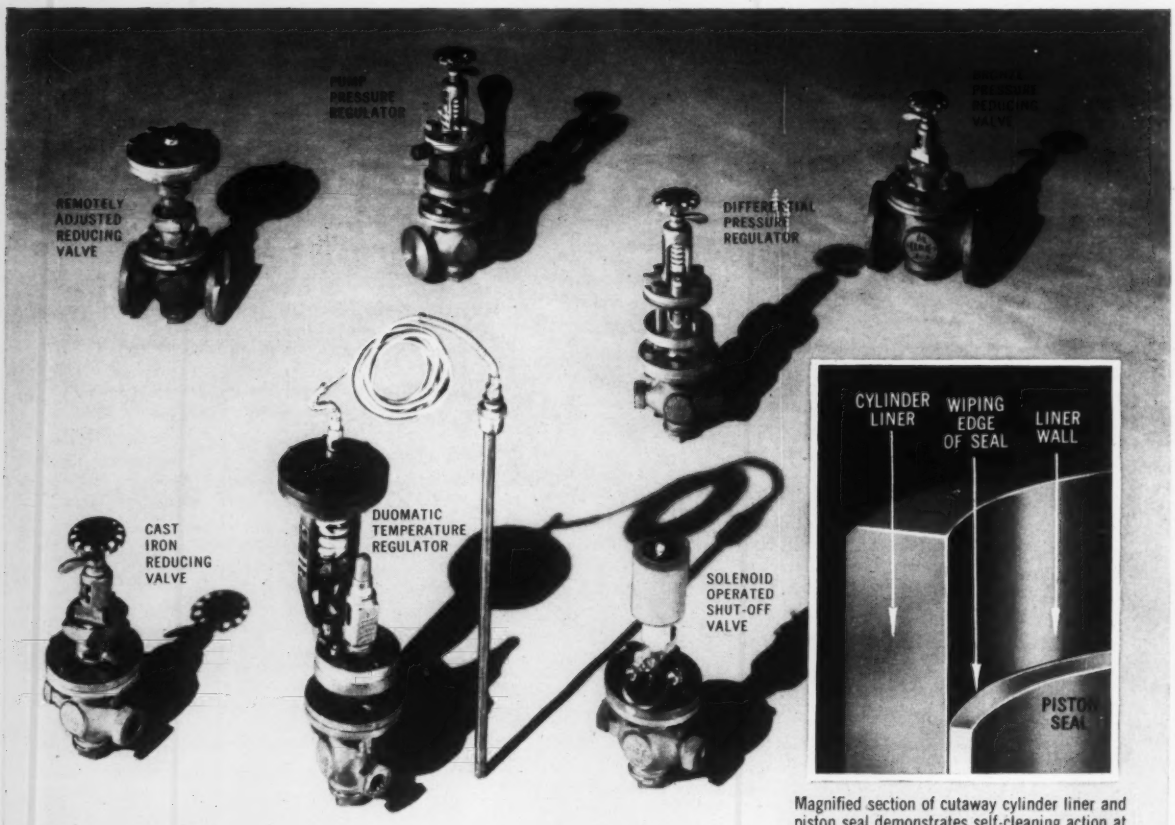

Magnified section of cutaway cylinder liner and piston seal demonstrates self-cleaning action at point of contact between seal and liner. Liner wall is swept clean of contamination deposits.

. . . another LESLIE Quality First!

REGULATORS WITH SELF-CLEANING PISTONS

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Now it can be told! After 3 years of exhaustive field tests and over 5,000 installations, Leslie announces the standardization of exclusive self-cleaning, pressure sealing pistons for reducing valves, temperature and pressure regulators in ½ to 6" sizes — another Leslie FIRST!

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The continuous "wiper" action of the new piston's seal keeps the cylinder liner clean, improves reliability, reduces maintenance.

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The resilient cushion between the piston and cylinder liner reduces wear and eliminates "freezing" or sticking of these parts. The self-lubrication and pressure-sealing of the new piston insures smooth, dependable operation even in the toughest applications and where long standby periods are a problem with ordinary regulators.

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Applications of REGULATORS

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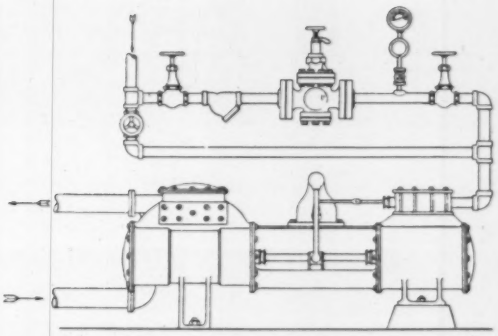

Fig. 7-1. Simple manually-adjusted regulator controls pressure of steam to the steam chest of a reciprocating pump, but is not sensitive to change in demand.

Basic applications of regulators include pump control, flowmeter line purging; bubbler-type liquid-level measurement, pressure reduction, temperature regulation, water box supply, and many, many others. The regulator can be remotely controlled.

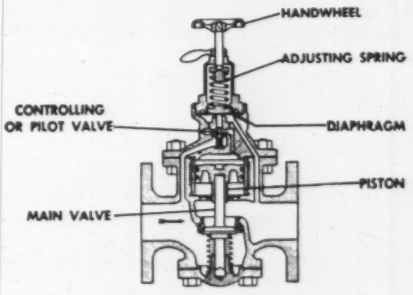

Fig. 7-2. Internal-pilot-type piston-operated pressure-reducing valve. The pilot provides accuracy; the piston provides high valve lift.

REGULATORS—valves that operate from the line variable without having an auxiliary source of power—require simple piping for installation. Here are some characteristic hook-ups.

Pump Control

If a reciprocating pump operates with fairly constant capacity or load, it will maintain constant discharge pressure—if the steam pressure to the pump chest is maintained constant. This can be done with a reducing regulator as shown in Fig. 7-1. An internal-pilot-type piston-operated regulator (Fig. 7-2) usually is recommended for this service, the pilot providing high accuracy and the piston providing the necessary valve lift.

Fig. 7-3 shows a system whereby the reciprocating pump is regulated against changes in both demand (output discharge pressure) and supply (steam

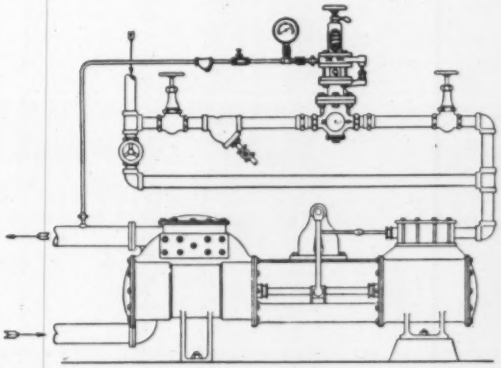

Fig. 7-3. Typical installation whereby a reciprocating pump is regulated against changes in both demand and supply.

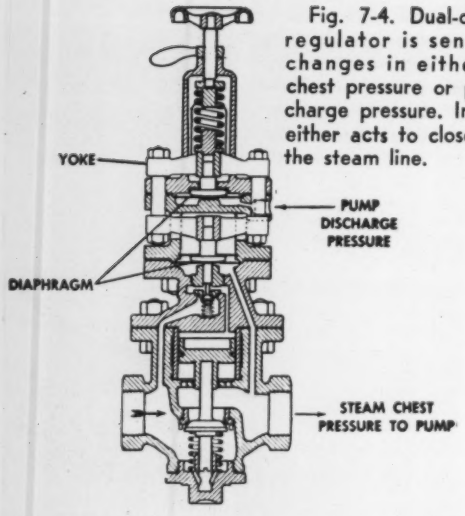

Fig. 7-4. Dual-diaphragm regulator is sensitive to changes in either steam chest pressure or pump discharge pressure. Increase in either acts to close valve in the steam line.

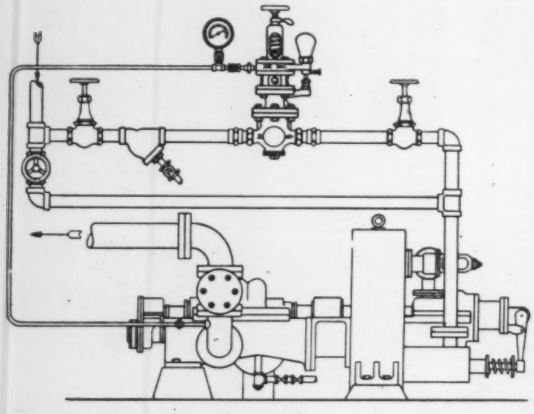

Fig. 7-5. Turbine-operated pump reacts quickly to control and can become unstable unless a regulator with proper response is used. This regulator has a reset mechanism to control its response.

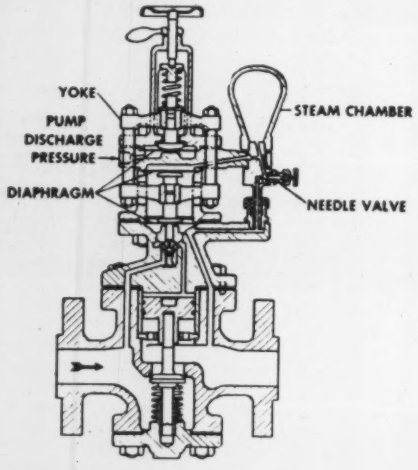

Fig. 7-6. Needle valve and external steam chamber provide a time constant that delays the reset pulse from reaching the middle diaphragm.

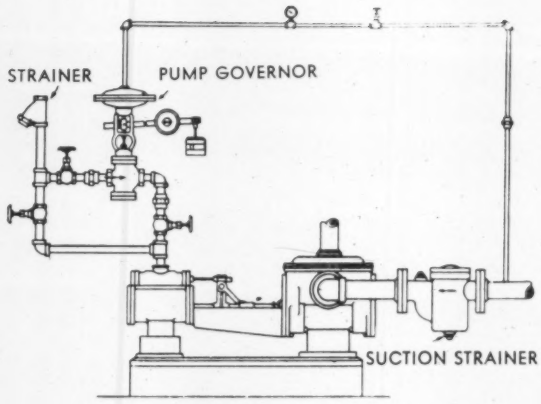

Fig. 7-7. Diaphragm-operated weight-loaded regulator maintaining a constant suction on a steam-driven reciprocating pump.

pressure). Here a pump governor of the type shown in Fig. 7-4 can be used. The piston that controls the inner valve is positioned by (1) the pump discharge pressure acting upward on the upper diaphragm and (2) the steam-chest pressure acting upward on the lower diaphragm. An increase in either acts to close the inner valve.

Fig. 7-5 shows how a turbine pump is regulated. The circuit is similar to that of Fig. 7-3 except that the regulator used has a third diaphragm and a steam-chamber volume (Fig. 7-6) by which the regulator response can be adjusted. Note that the steam discharge pressure acts upward against the lower diaphragm but downward against the middle diaphragm. However, the pressure impulse is delayed from reaching the middle diaphragm because of the adjustable needle valve and the volume of the external steam chamber. This gives the system stability because of the tendency of the turbine pump to react instantly and become unstable.

Vacuum Pump Governor

It often is necessary to maintain a constant suction or vacuum on the return line of a steam-driven reciprocating or rotary vacuum pump. Fig. 7-7 shows how this is done.

Flowmeter Line Purging

Fig. 7-8 shows how a simple *differential regulator* is used to purge the lines of a flowmeter so that the fluid in the main pipeline cannot reach the flowmeter. The differential regulator (Fig. 7-9) is connected so that the pressure on the upstream side of the needle valve (shown mounted on top of the flow indicator in Fig. 7-8) acts on the underside of the diaphragm; the pressure on the downstream side of the needle valve acts on the top of the diaphragm. The spring exerts a fixed downward pressure equivalent to, say, 3 psi on the top of the diaphragm. Hence the pressure down-

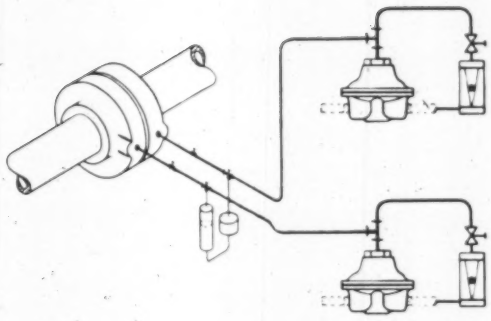

Fig. 7-8. Orifice-meter line-purging arrangement uses a differential regulator, a rotameter, and a needle valve.

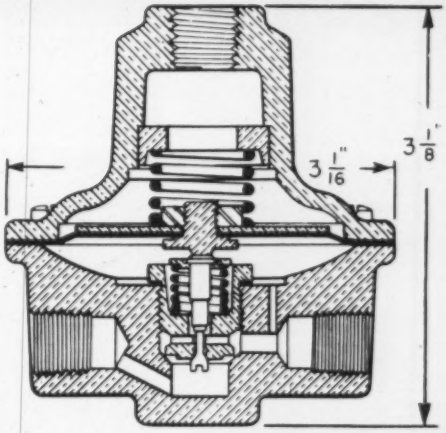

Fig. 7-9. Differential regulator maintains constant differential across diaphragm.

stream of the needle valve must remain 3 psi *less* than the pressure upstream of the needle valve, regardless of the absolute values of these pressures. Under these conditions there is a constant rate of flow of purging fluid through the rotameter and through the flowmeter lines—regardless of variations in upstream or downstream pressure on either side of the needle valve. This prevents the fluid in the main line from coming in contact with the meter body, yet permits the flowmeter impulses to register on the flowmeter. Air, water, or inert gas are commonly used purging media.

Liquid Level Measurement

The differential regulator, plus the needle valve and flow indicator, is also used commonly as a simple and effective instrument for measuring liquid level in an *open tank*, as shown in Fig. 7-10. The differential regulator always maintains a constant *flow rate* through the medium in the tank; hence the static pressure in the line downstream of the needle valve is always equivalent to the liquid head in the tank, and can be measured in terms of liquid level as shown.

In closed vessels, water or the measured fluid can be used as the purging medium to give an indication of level.

Fig. 7-11 shows a level control situation using a float-and-lever-actuated regulator.

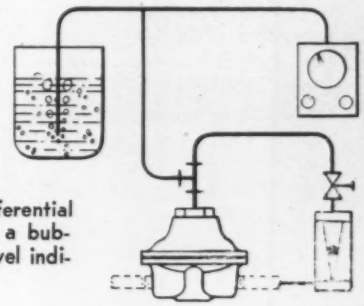

Fig. 7-10. Differential regulator used as a bubbler-type liquid-level indicator.

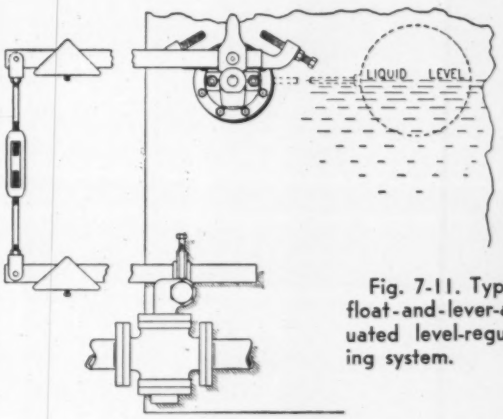

Fig. 7-11. Typical float-and-lever-actuated level-regulating system.

Humidity Measurement

In wet-and-dry-bulb psychrometer and humidity-controller installations a *water box* is necessary to supply water to the wet bulb. Fig. 7-12 shows how a differential regulator is used to supply a constant rate of flow to the water box containing the bulb, which is located in a pipe under considerable pressure. The height of the liquid in the water column is proportional to the rate of flow of water to the water box.

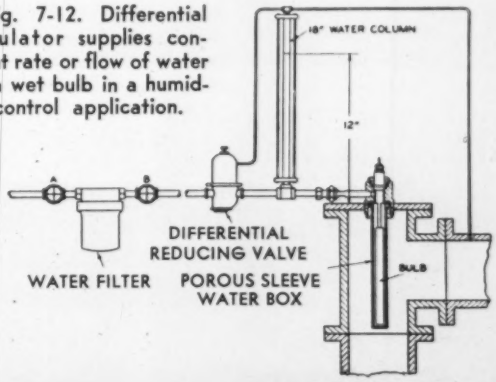

Fig. 7-12. Differential regulator supplies constant rate or flow of water to a wet bulb in a humidity-control application.

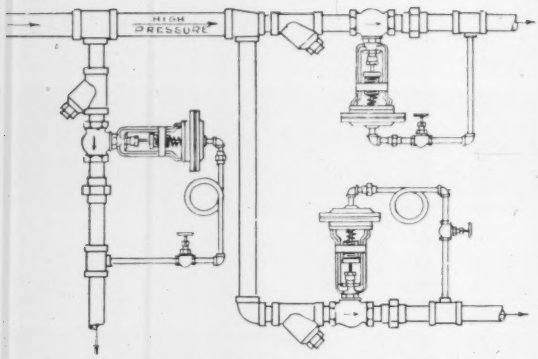

Fig. 7-13. Spring-loaded pressure-reducing regulator can be mounted in any position.

Pressure Reduction

Typical installations of spring-loaded reducing regulators (Fig. 7-13) reveal the versatility of this type, which can be mounted in any position as shown. The loops in the downstream connections to the diaphragm chamber provide a water seal, preventing steam from coming into direct contact with the diaphragm. Upside-down installation in a horizontal line, as shown at upper right in Fig. 7-13, saves this extra siphon.

Figs. 7-14 and 7-15 show a regulator for oil-burner pressure.

Temperature Regulation

A typical installation of a *temperature regulator* on a storage heater (Fig. 7-16) shows the capillary connection from the bulb to the internal-pilot-operated regulator. Both are supplied with the regulator, which —as is the case with all regulators—is installed directly in the steam piping to the heater.

Remote Operation

A pressure regulator can be installed at the most appropriate location in a steam line, and adjustment of the control point can be achieved from a *remotely-mounted* pilot, is illustrated in Fig. 7-17. The main regulator is actuated by an externally-mounted pilot which is in turn loaded by condensate received from a small pressure reducing valve at the lower left. This arrangement is less expensive than rerouting the main piping.

Acknowledgment

Illustrations are by courtesy of Atlas Valve Co., Conoflow Corp., Fisher Governor Co., The Foxboro Company, General Controls Co., Leslie Co., Mason-Neilan Div., and Spence Engineering Co.

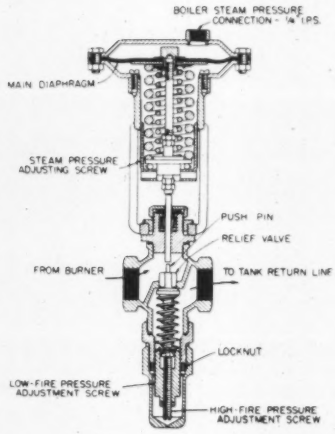

Fig. 7-14. Oil burner pressure is regulated according to demand of steam boiler. Note that stem is not continuous to permit low-fire and high-fire pressure adjustment.

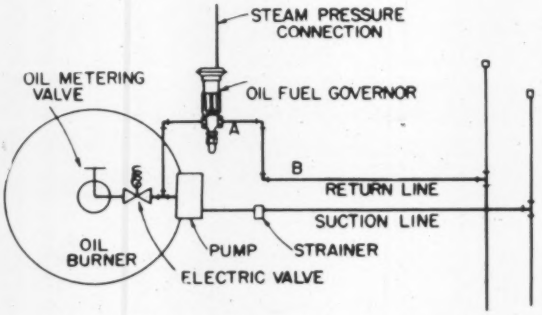

Fig. 7-15. Oil fuel governor is installed in return line from oil burner.

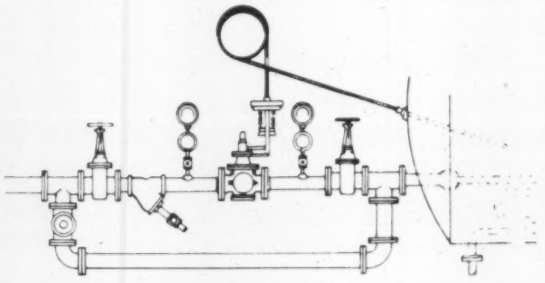

Fig. 7-16 Typical application of a temperature regulator on a storage heater.

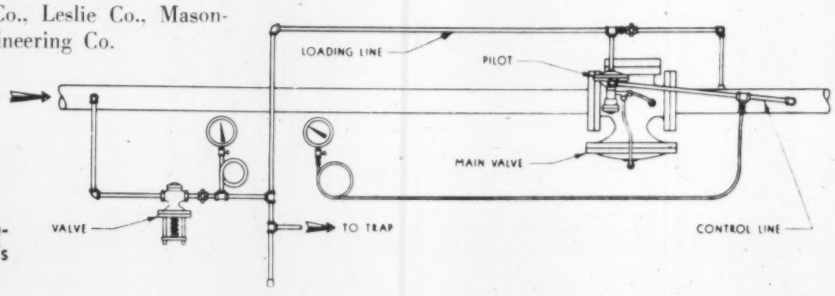

Fig. 7-17. Remote operation of a regulator is possible via a pilot.

FIG. 1. RESISTANCE BRIDGE INDICATOR provides digital readout.

Bridge and EMF Measurements via the Resistance Bridge Indicator

The Resistance Bridge Indicator is a servo-balanced instrument for efficient use of resistance-bridge transducers such as strain gages, resistance thermometers, and load and pressure cells—and can be used also as a potentiometer.

RICHARD E. GEORGE

Datran Electronics

BASIC PRINCIPLE of operation of the Resistance Bridge Indicator (RBI) involves the comparison of two related voltages to perform a null-balance measurement of the output signal of a resistance bridge that is entirely outside the instrument (Fig. 2). This allows the instrument to be used with a host of transducers with a wide range of output resistances because the external bridge can be changed to match whichever transducer is being used. Also, because the same power source drives the bridge and the RBI, an unstabilized power supply is adequate.

Operation

The resistance bridge transducer—the input bridge—is normally operated unbalanced. The bridge output voltage, or current, is measured directly to determine the extent of relative resistance unbalance in the bridge resistors. This is in contrast to the balanced wheatstone-bridge method of continually nulling the bridge output by controlling one or more adjustable arms of the bridge.

Unbalanced operation has many advantages in test work, and nearly all resistance-bridge transducers are designed to operate in this manner. However, the four-arm resistance-bridge transducer is a four-terminal network in which the output signal leads do not have a common connection with the bridge power input. The problem of comparing output and supply voltages therefore involves some special considerations not ordinarily encountered in conventional null-balance measuring equipment. One

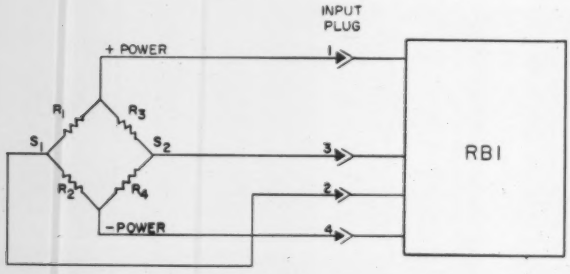

FIG. 2. BLOCK DIAGRAM SHOWS RBI receiving input from external resistance-bridge transducer.

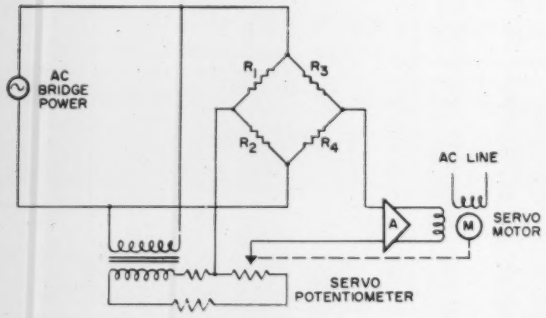

FIG. 3. CONVENTIONAL NULL-BALANCE technique generates a voltage equal to the unbalanced signal arriving from resistance bridge.

widely used method uses an a-c supply for bridge excitation, and employs a transformer to provide an isolated reference voltage, as shown in Fig. 3. This technique is excellent for fixed installation where parasitic capacitances are essentially constant, and where care can be taken to minimize extraneous noise pickup in the low-level signal leads. For general-purpose test work, however, direct-voltage bridge excitation is often preferred because of freedom from capacity effects and because filtering of stray pickup is relatively simple. The Resistance Bridge Indicator employs special circuitry to use bridge power while maintaining calibration independent of voltage variations. Calibration also is independent of the absolute value of initial bridge resistance over a wide range.

As shown in Fig. 4, the transducer signal lead S_2 is connected to the servo balancing resistances R_b. Transducer output signal is the difference between the voltages appearing as S_1 and S_2, or (e_1-e_2). The servo balancing voltage, equal and opposite to the transducer output voltage, is developed across the resistance R_s.

To maintain symmetry, which is necessary with some temperature-compensated transducers, S_1 is connected to a "dummy" servo network whose total resistance is one-half R_b. The electrical loading of the transducer by the servo networks is negligible; the usual transducer resistance is the range from 50 to 500 ohms, and the resistance R_b is approximately 500,000 ohms.

The dual, ganged, servo-balance potentiometers have contact arms arranged to rotate in opposite directions. Because of the high sensitivity of bridge transducers to shunting effects, a single servo-balancing network would create an unwanted component of bridge-voltage output due to the shunting of R_3 and R_4. This component of bridge output would vary with absolute transducer resistance, thereby causing an error in calibration for the range of transducer resistances commonly employed in testing application. The dual-balancing network is effective in preventing this unwanted component of signal voltage and the general node equation at S_2 does not contain any terms involving x; this means that bridge output voltage is unaffected by the positioning of the servo potentiometers.

In practice, many transducers incorporate temperature compensating resistors in addition to the basic bridge elements shown in Fig. 4. Analysis shows that for the commonly employed methods of compensation, the dual-potentiometer balance arrangement is equally effective in preventing bridge output due to shunting.

The significant advantage is that the basic calibration is in millivolts output of a resistance bridge, *per volt applied*, essentially independent of the impedance characteristics of the input. This calibration is non-dimensional and can be stated in terms of percent resistance change of a bridge arm, or, when strain gages are employed, directly in microinches per inch strain.

Application

Panel controls of the RBI provide for practically all resistance-bridge transducers. Instrument span is adjustable either in fixed steps or continuously from nominally 0.5 millivolt/volts bridge voltage to 20 millivolts/volt bridge voltage. A variable calibration control allows for adjustment of calibration between the fixed steps, and also compensates for the normal spread in "gage factor" of various types of strain gages. Readout can be directly in microinches per inch for 1, 2, or 4 active-arm strain-gage bridge inputs.

Additional controls are for full or half bridge, signal polarity, zero balance, and for shunt resistance calibration. The instrument also incorporates a filtered d-c voltage supply for bridge power so no external apparatus of any kind is required for most resistance-bridge measurements.

Nominal response time of the servo employed in the standard instrument is 4 seconds for 1000 counts full scale of the digital readout.

If a half bridge is to be employed instead of the full bridge shown in Fig. 2, only R_1 and R_2 will be required as input.

Input Bridge Considerations

The main considerations of the input bridge are as follows:

1. The initial resistance of all bridge resistors should be nearly equal (within a few percent). If this is not possible, then at least the ratios of R_1/R_2 and R_3/R_4 should be approximately equal.

2. Lead resistance should be kept reasonably small, particularly when employing half-bridge inputs. The power leads are much more critical in this respect than are the signal leads. In certain cases, it may be necessary to run separate leads to power the bridge, and to return an individual pair of leads, for reference voltage, from the actual bridge location to the RBI.

3. Depending upon the characteristics of the input, large signals may result in the bridge voltage becoming increasingly nonlinear with respect to resistance change, or with respect to the primary variable which results in the resistance change. To obtain maximum accuracy, this nonlinearity should either be calculated or directly measured. As a rule of thumb, for a 0 to 2% change in one arm of a resistance bridge (5 mv/volt output), the nonlinearity amounts to approximately 1% of full scale.

4. If either R_3 or R_4 or both are active bridge arms, the variation at S_2 will either add to or subtract from the available servo balancing voltage, depending on polarity. This effect results in a second-order change in the instrument calibration of approximately $\pm 0.2\%$ per millivolt change S_2, per volt bridge voltage. For this reason, where the active arms are in one half of the bridge only, the input should always be wired with R_1 and R_2 as the active arms.

Errors due to the input bridge nonlinearity or to other repeatable effects can readily be corrected if the input bridge and the RBI are calibrated together. If this is done, then an over-all accuracy within 0.1% of full scale is feasible because of the sole dependence of the basic calibration on precision resistance networks, independent of voltage sources.

Signal voltage into the RBI is in no way limited to a resistance-bridge source. By employing a stable reference-voltage supply, such as a mercury battery, the instrument can be used readily as a self-balancing potentiometer for measuring various types of millivolt sources. Fig. 5 shows a simple method of adapting the RBI to measure millivolts from approximately 1 millivolt full scale to 40 millivolts full scale. If external attenuation is used in the signal leads, it is possible to measure voltages up to 100 volts full scale. The input resistance of the RBI in this mode of operation is approximately 500,000 ohms.

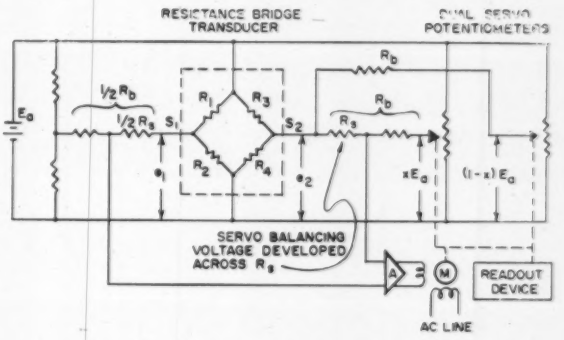

FIG. 4. RBI SIMPLIFIED schematic.

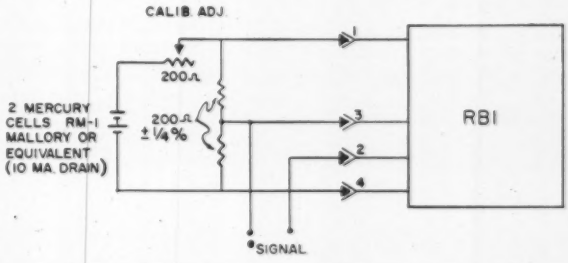

FIG. 5. MILLIVOLT measurements using the RBI.

Specific Uses

A major field of application of the Resistance Bridge Indicator is strain-gage work. This would include experimental stress analysis, structural proof-testing, monitoring of structural loads, etc.

In addition, there are many types of packaged resistance-bridge transducers available for measurement of variables such as pressure, weight, temperature, deflection, acceleration, etc. The RBI also is capable of measuring the millivolt output of thermocouples and other low-level transducers, and can serve many functions in physical test applications.

The high-torque servo-balanced measuring system can be employed readily with most shaft-position analog-to-digital converters in automatic digital recording of test data. The servo is designed so that one such converter (the Coleman "Digitizer") can be installed without disassembly of the instrument.

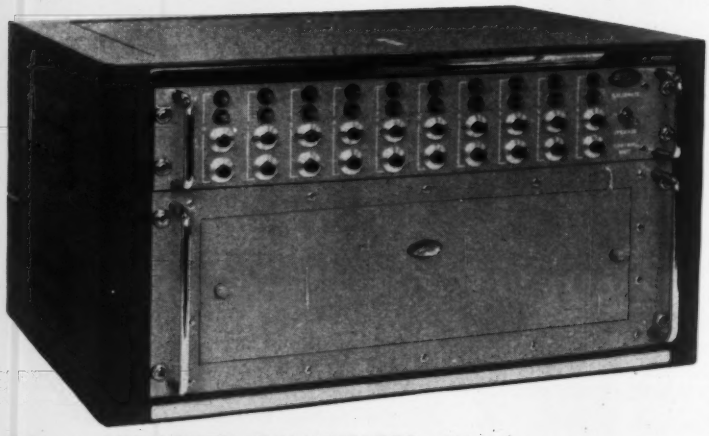

FIG. 1. HIGH-SPEED COMMUTATOR, Wiancko Series 25-1100.

ROBERT K. BUNCE
Wiancko Engineering Co.

High-Speed Commutator

DIGITAL AUTOMATION NO. 25

This small, solid-state, high-speed, electronic commutator samples inputs from up to 100 pickups at speeds up to 30,000 samples per second.

THERE is great need for a high-speed commutation device in low-level, high-speed data systems. This 100-channel commutator (Fig. 1) uses solid-state elements exclusively and accepts either a-c or d-c inputs from ± 10 millivolts to ± 5 volts full scale. Total power requirements are approximately 8 watts. The commutator is adaptable to FM telemetering systems, AM or DC data systems, etc.

The heart of the commutation scheme is an "AND" gate using silicon diodes (Fig 3). The "AND" gate receives three inputs but conducts only when the three appear simultaneously.

There are 100 "AND" gates in the 100-channel commutator. The middle input to any one (Fig. 3) is the signal input from a transducer or an input device. It is the signal that is to be fed to the output at the proper time.

The other two inputs are control signals from the "tens-control" and "units-control" counter circuits of the commutator. These are simply counting circuits that count from 1 to 100 and enable each of the one hundred "AND" gates in succession (Fig. 4).

The output of the "AND" gate is independent of the absolute value of the control voltage (as long as it exceeds a minimum value). This allows the use of non-critical transistorized ring counters as control elements. An unusual arrangement of the stages in the ring counters, possible only with transistors, removes the possibility of double triggering or instability (usually experienced with extended vacuum-tube ring configurations) and provides commutation speeds up to 30,000 channels per second.

Flexibility is obtained by arranging the drive matrix so that blocks of ten channels at a time can be dropped without introducing dead time. Switching is initiated by an input clock pulse on a once-per-channel basis so that practically any sampling rate or sequence of sampling rates up to the highest can be programmed in the system.

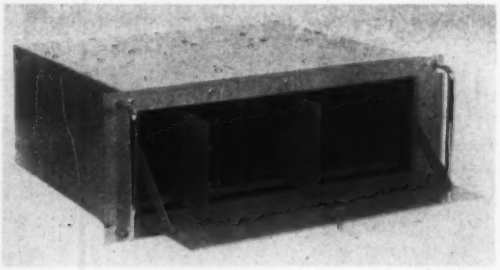

FIG. 2. FUNCTION BOARDS are printed circuits in modular packaging.

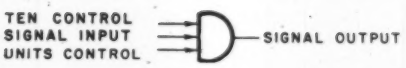

FIG. 3. "AND" GATE conducts signal only when tens'-control bias and units'-control bias occur simultaneously.

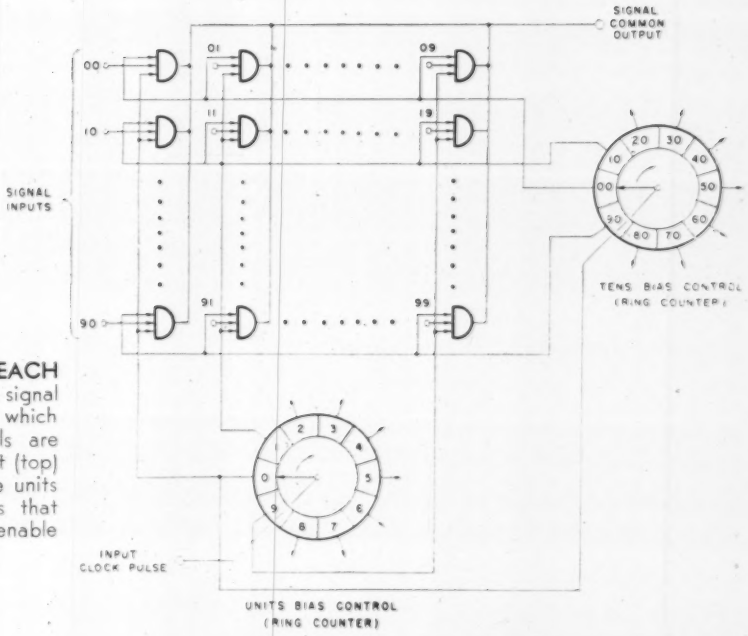

FIG. 4. CENTER INPUT TO EACH "AND" GATE always carries signal from transducer or channel to which it is connected. These signals are passed through to signal output (top) in sequence determined by the units and tens ring-counter outputs that are connected as shown to enable one **"AND"** gate at a time.

A self-contained diode matrix (Fig. 5) supplies binary-coded-decimal channel-identification pulses which can be used for identification or check functions. Single-channel operation in any sequence is afforded by a compact control chassis. The gating circuits are packaged in convenient blocks of ten (Fig. 2).

Resolution to 0.1% or better is obtained on the lowest input range. Inherent noise levels are less than 10 microvolts (measured 10 microseconds after switching), and cross-channel attenuation for d-c inputs is greater than 100 decibles. The commutation unit is packaged in a relay-rack mount approximately 7¼" high, 19" wide, and 12½" deep. An airborne package also is available.

Table 1—Specifications

Power requirements	Supplied from Wiancko power supply type 12-1148 or equivalent.
Number of channels	100, reducible in blocks of 10
Input signal	up to ±6 volts, normal operation. Self limiting at ±8 volts.*
Noise	Less than 10 microvolts
Switching time	10 microseconds, maximum
Output load impedance	10,000 ohms minimum for 600 millivolts maximum. 100,000 ohms minimum for 6 volts maximum.
Cross channel attenuation**	Greater than 100 DB for DC inputs, 100 ohm source impedance. Greater than 60DB for DC inputs, 10,000 ohms source impedance. Greater than 60DB for AC inputs at 10,000 cps, 100 ohm source impedance.
Drift (zero and sensitivity)	± 0.05% or less
Linearity	± 0.05% or better
Sampling rate	Up to 30,000 samples per second
External clock pulse requirements	5 volts negative pulse 0.5 microseconds rise time maximum. 10 microseconds duration minimum.
Channel identification	8 line parallel binary-coded-decimal output.
Modes of operation	
a) Operate	Clock controlled, continuous.
b) Calibrate	Clock controlled, single cycle.
c) Manual	Selection of any of 100 channels by means of 20 pushbutton switches.
Size	
a) Commutator type 25-1101	7 in. high x 12½ in. deep (excluding connectors)
b) Control unit type 19-xxxx	3½ in. high x 6 in. deep (excluding connectors)
Total weight	Approximately 20 pounds

*Other limiting levels less than ±8 volts available.
**Maximum coupling to one "on" channel with full signal applied to 99 "off" channels.

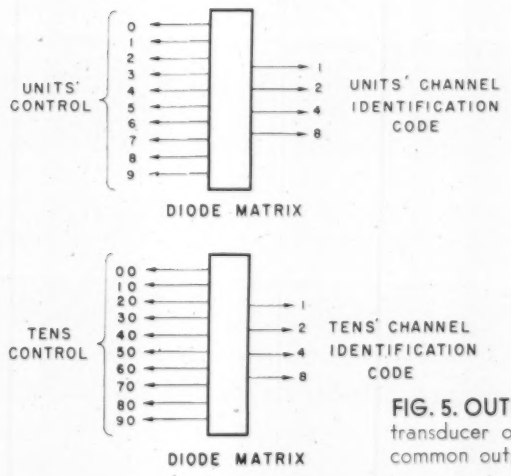

FIG. 5. OUTPUT FROM DIODE MATRIX identifies the transducer or channel that is gated through to the common output.

Here is the list of equipments, philosophy of test, and calibration schedule for a reference standards laboratory of a large manufacturer of precision equipments. Included are instruments purchased for a primary and a secondary standards laboratory for calibration of voltage, current, resistance, capacitance, inductance, power, temperature, weights and measures, pressure and vacuum, length, acoustics, flow and vibration. Total cost, excluding secondary instruments, was below $50,000.

W. M. KIDWELL
AiResearch Mfg. Div.
The Garrett Corp.

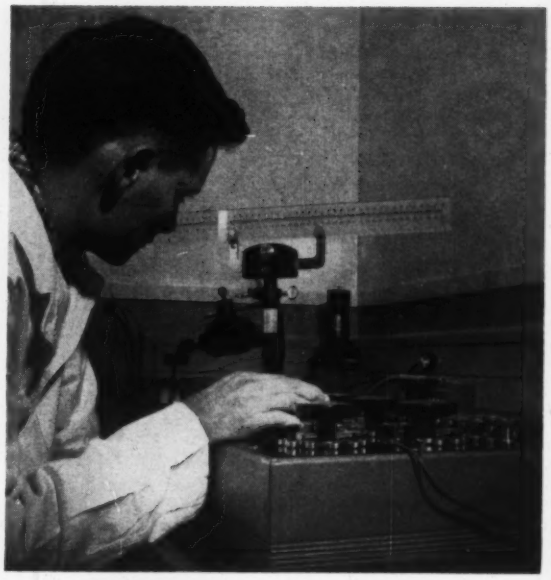

FIG. 1. PRECISION TEMPERATURE measurements with an L&N Mueller bridge.

EQUIPMENT FOR A STANDARDS LAB

AIRESEARCH STANDARDS LABORATORY shows how modern industry meets the challenges imposed by the test requirements for precision products developed for aircraft and missiles.

The many and varied products of AiResearch—the world's largest manufacturer of turbo-machinery, valves, and other aircraft and electronic components and systems—require a great number of electronic test instruments as well as many mechanical gages and a varied assortment of jigs and fixtures.

By providing a common reference point for all measurements within the company via a standards laboratory, greater coordination and correlation of measurements is made possible between the departments involved in manufacturing, test, and quality control.

Although there are many other fine measuring instruments available that are not listed here, the list given here is a compromise between reasonable cost and high performance. The list of secondary instruments supplied in this report is given to show the relationship of tolerances between standards.

The phrases *Primary Standards* and *Secondary Standards* refer to AiResearch only because every laboratory of this type is really secondary to the National Bureau of Standards.

Every effort has been made to purchase the finest equipment available, within budgetary allowances, and to provide a suitable controlled environment to insure optimum performance.

As the measurements obtained can be no more precise than the methods employed by the operating personnel, thorough and constant indoctrination of the laboratory personnel, in proven measuring techniques, results in the proper balance of good personnel and precise equipment.

Calibration Tolerance Ratios

The trend to higher degrees of precision has occasioned difficulty in maintaining adequate basic standards of measurement. Requirements for more precise measurements are pressing the ability of instrument makers to provide basic primary standards in the accepted and proper ratio of accuracy.

This ratio for tolerance between the object under measurement and its calibrating device has become widely accepted as the ratio of 10:1. For example, consider a mortar shell which is gaged under the standard Navy philosophy. The accuracy of the gage used to measure the shell diameter is ten times the tolerance

Table 1—Standards of Frequency and Time
Primary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. FREQ.
1	Berkeley 5590 W.W.V. Receiver	5-10-15-20-25 Megacycles	Abs. less phase error	N.B.S. daily
1	H-P 524B Electronic Counter	10 cps to 10 mc	2PPM/ week	N.B.S. daily
1	H-P 525A Converter	10-100 mc	2PPM/ week	N.B.S. daily
1	Syncronometer			
1	Comparison Oscilloscope			

Table 2—Standards of Frequency and Time Secondary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. FREQ.
1 M	Gertsch FM-3 Frequency Meter	20-640 mc	0.001%	90 days
1 M	Berkeley 5510 Counter	1mc/3 microsecond	0.0001%	30 days
1 M	H-P 200C Audio Oscillators			90 days
1 M	H-P 522B Counter	10 microseconds to 100,000 microseconds 10 cps-100 kc	5PPM/week	30 days
1 1	H-P No. 522B Counter	"	"	30 days
1 1	H-P No. 521A Counter	1 cps to 120 kc	0.1% ± 1 count	30 days
2 1	Berkeley 554 Counters	.1-1 and 10 seconds	1 x 10^{5}	30 days
3 1	Berkeley 5510 Counters	1 mc/3 microsecond	0.0001%	30 days

Table 3—Standards of Voltage AC and DC Primary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. FREQ.
1	Weston Model 325 D.C. Voltmeter 100 Ohms Per Volt	300-150-75-30-15-7.5-3	0.1%	Yearly
1	Weston Type 21 Precision External Resistor	600 V	0.1%	Yearly
1	Weston Type 22 Multiplier Box	1500 V	0.1%	Yearly
1	Weston Type 23 Multiplier Box	3000 V	0.1%	Yearly
2	Weston Type 23 Multiplier Boxes	6000 V	0.1%	Yearly
1	L&N K3 Potentiometer	0-1.611 V	0.01% +2 microvolts	Yearly
4	Weston Model 4 Type 3 Standard Cells		0.01% ABS	Yearly
1	Weston Model 326 A.C. Voltmeter	300-150-75	0.1%	Yearly
1	Weston Model 311 Type 2 Potential Transformer	6900-3450 to 115 V Normal 9000-4500 to 1504 Max.	Less than 0.1%	Yearly
1	Weston Model 311 Type 3 Standardizing Potential Transformer	30-15-7.5-3-1.5	Less than 0.1%	Yearly
1	Weston Model 311 Type 1 Potential Transformer	3000-1500-150	Less than 0.1%	Yearly
1	L&N 4395 Voltage Divider D.C. (Same as resistant standard)	100,000-1	0.05%	Yearly
1	L&N Voltage Divider A.C.	100,000-1	0.05%	Yearly
1	Gertsch PT5 Standard Ratio Transformer			
1	Weston Model 311 Type 1 Potential Transformer	600-300-150	Less than 0.1%	Yearly

Table 4—Standards of Voltage AC and DC Secondary Standards Laboratory

QUANTITY AND CODE	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1 M	Weston 341 AC-DC Voltmeter	0-15-30	¼%	90 days
1 M	Weston 341 AC-DC Voltmeter	0-75-150-300-600V	¼%	90 days
1 M	Weston 622 AC-DC Voltmeter	0.5-2-5-20V	½%	90 days
1 1	Hycon 615 VTVM	0-10-100-1000V AC 1-10-100-1000V DC	3%	90 days
3 1	Weston Model 1 DC Voltmeter	0-3-7.5-15V	¼%	90 days
3 1	Weston 931 DC Voltmeter	0-30V	½%	90 days

Table 5—Standards of Electrical Current AC and DC Primary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. FREQ.
1	Weston 325 D.C. ammeter 100 mv	200/100/50	0.1%	Yearly
1	Weston precision shunt 100 mv	5 amps	0.1%	Yearly
1	Weston precision shunt 100 mv	10 amps	0.1%	Yearly
1	Weston precision shunt 100 mv	200 amps	0.1%	Yearly
1	Weston precision shunt 100 mv	500 amps	0.1%	Yearly
1	Weston precision shunt 100 mv	1000 amps	0.1%	Yearly
1	Weston precision shunt 100 mv	2000 amps	0.1%	Yearly
1	Weston precision shunt 100 mv	.1 amp	0.1%	Yearly
1	Weston precision shunt 100 mv	.2 amp	0.1%	Yearly
1	Weston precision shunt 100 mv	.5 amp	0.1%	Yearly
1	Weston precision shunt 100 mv	1 amp	0.1%	Yearly
1	Weston precision shunt 100 mv	2 amps	0.1%	Yearly
1	Weston precision shunt 100 mv	20 amps	0.1%	Yearly
1	Weston precision shunt 100 mv	50 amps	0.1%	Yearly
1	Weston precision shunt 100 mv	100 amps	0.1%	Yearly
1	Weston Model 326 A.C. Ammeter	5/2.5	0.1%	Yearly
1	Weston Model 327 Type 2 Current Transformer	1200/600/400 300/200/100 50/20/10 to 5 secondary	0.1%	Yearly

Table 6—Standards of Electrical Current AC and DC Secondary Standards Laboratory

QUANTITY AND LOCATION	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1 M	Weston 45 DC Millivoltmeter	0/50 mv	½%	90 days
1 M	Weston Portable Shunt, 50 mv	5 amps	½%	90 days
1 M	Weston Portable Shunt, 50 mv	10 amps	½%	90 days
1 M	Weston Portable Shunt, 50 mv	20 amps	½%	90 days
1 M	Weston Portable Shunt, 50 mv	50 amps	½%	90 days
1 M	Weston Portable Shunt, 50 mv	100 amps	½%	90 days
1 M	Weston Portable Shunt, 50 mv	200 amps	½%	90 days
1 M	Weston Portable Shunt, 50 mv	500 amps	½%	90 days
1 M	Weston 622 AC-DC Milliammeter	0/1.5 Ma	½%	90 days
1 M	Weston 622 AC-DC Milliammeter	5/20/100/500 Ma	½%	90 days
1 M	Weston 622 DC Microammeter	0/50/100/200/500/1000 microamps	½%	90 days
1 M	Weston 370 AC-DC Ammeter	0/1/2 amp		90 days
1 M	Weston 370 AC-DC Ammeter	0/.5/1 amp		90 days
1 M	Weston 370 AC-DC Ammeter	0/5/10 amp		90 days
1 M	GE Type P3 AC Ammeter	0.5/1 amp	2/10%	90 days
2 M	Weston 461 Type Current Transformer	10/20/50/100/200/400/800 amp		90 days
1 M	Weston 327 Current Transformer	2000/2500		90 days
5 1	Weston 327 Type-2 Current Transformer	1200/600/400/300/200/100/50/20/10		90 days
3 1	Weston Model-1 DC Ammeters	0/100 0/150 amps	0.25%	90 days
4 1	Weston 433 AC Ammeters	.75/1.5/3 amps	0.75%	90 days
2 1	Weston 433 AC Ammeters	0/5/10 amps	0.75%	90 days
1 1	Weston 931 DC Milliammeter	0/150/1500	½%	90 days

allowed for the shell measurement. This line gage is calibrated by a secondary standard—a gage that is ten times more accurate than the first. The *secondary* standard gage is calibrated, for reasons of wear and rough usage, against another gage—a *primary standard* which is ten times more accurate than the secondary standard. This primary standard must be maintained under ideal conditions in order to retain its accuracy and, subsequently, the accuracy of the whole system.

Modern accuracy requirements in *mechanical gaging* make it difficult to design standards of measurement, but even these are not nearly so difficult as in the measurement of *pressure* or *electrical quantities* because in these fields the state-of-the-art of measurement has not progressed as fast as the requirements. Very often we must compromise accuracy to be realistic and to stay within reasonable cost.

Basic Test Philosophy

In setting up a Primary Standards Laboratory one of the first considerations is to establish a philosophy of test—the tolerance structure of measurement mentioned previously—recognizing that primary standards are just not available to maintain a desired 10:1 ratio of tolerance structure. There are two ways to approach this problem:

1. Ascertain if the requirement for extreme accuracy is necessary. Much detailed analysis is often necessary to prove the validity of exceptionally high accuracy requirements.

2. If the need is verified, the only course open is to use the 10:1 ratio as an objective and to buy equipment commensurate with cost and purpose that maintains as high a ratio as possible between the standards of measurement. A ratio of 4:1 or 5:1 is considered acceptable in modern practice.

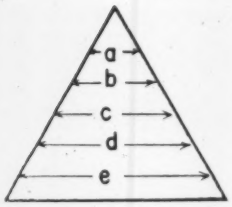

FIG. 2. MANUFACTURING TOLERANCES. a is design tolerance; b is product design tolerance; c is manufacturing tolerance; d is final test tolerance; e is field test tolerance.

FIG. 3. CALIBRATION TOLERANCES. A is National Bureau of Standards tolerance; B is primary standards laboratory tolerance; C is secondary standards laboratory tolerance; D is line and test lab instrumentation tolerance.

Setting the Tolerance Structure

The tolerance structure is shown by the well-known and generally-accepted tolerance pyramid (Fig. 2), which shows the *design* tolerance, *product design* tolerance, *manufacturing* tolerance, *final test* tolerance, and *field test* tolerance.

The concept of test structure is shown in Fig. 3. The calibrating standards for instruments required at C of Fig. 3 may be in the primary standards laboratory because of the environmental control required.

Frequency of Calibration

In any standards laboratory the accuracy needed in measurements may differ widely on different projects. Hence the frequency with which the working instruments are checked can vary from project to project.

The frequency of calibration for measuring apparatus depends on a great many things such as (1) the volume of equipment to be tested, (2) the delicacy of the apparatus and, particularly, (3) the type of per-

Table 7—Standards of Electrical Current AC and DC Secondary Standards Laboratory

QUANTITY AND CODE	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
3 1	Weston Model 8 Precision shunts	150/75/30/15/7.5/3/1.5 amp 10-50 mv	½%	90 days
1 1	Weston 45 DC Millivoltmeter	0-50 mv	½%	90 days
3 1	Weston 370 AC DC Ammeters	2.5/5 amps A.C. 2.5/5 amps D.C.	0.25%	90 days
5 1	Weston Portable shunts 50 mv	500 amps	½%	90 days
2 1	Weston Portable shunts 50 mv	50 amp	½%	90 days
4 1	Weston Portable shunts 50 mv	300 amp	½%	90 days
2 1	Weston Portable shunts 50 mv	10 amp	½%	90 days
6 1	Weston Portable shunts 50 mv	750 amp	½%	90 days
1 1	Weston Portable shunt 50 mv	1000 amp	½%	90 days
4 1	Weston Portable shunts 50 mv	1500 amp	½%	90 days
1 M	Weston Portable shunt 50 mv	5 amp	½%	90 days
1 M	Weston Portable shunt 50 mv	10 amp	½%	90 days
1 M	Weston Portable shunt 50 mv	20 amp	½%	90 days
1 M	Weston Portable shunt 50 mv	50 amp	½%	90 days
1 M	Weston Portable shunt 50 mv	100 amp	½%	90 days
1 M	Weston Portable shunt 50 mv	200 amp	½%	90 days
1 M	Weston Portable shunt 50 mv	500 amp	½%	90 days

Table 8—Standards of AC and DC Resistance Primary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1	L&N 4230 Anthony Pattern Bridge	0-11,111 ohms	not less than 0.02%	Yearly
1	Otto Wolff Precision Resistor	0.1 ohm	0.01%	Yearly
1	Otto Wolff Precision Resistor	0.01 ohm	0.01%	Yearly
1	Otto Wolff Precision Resistor	0.001 ohm	0.01%	Yearly
1	L&N 4020C Precision Resistor	1 ohm	0.01%	Yearly
1	L&N 4025C Precision Resistor	10 ohms	0.01%	Yearly
1	L&N 4030C Precision Resistor	100 ohms	0.01%	Yearly
1	L&N 4035C Precision Resistor	1000 ohms	0.01%	Yearly
1	L&N 4040C Precision Resistor	10,000 ohms	0.01%	Yearly
1	Otto Wolff Precision Resistor	100,000 ohms	0.01%	Yearly
1	L&N 4320 Kelvin Bridge Ratio Box			
1	L&N 4249 One Megohm Resistance Standard	1,000,000 ohms	0.02%	Yearly
1	L&N 4300 Kelvin Bridge	0.00000001 ohm to 1 ohm	0.04%	Yearly
1	L&N 4755 A.C. Resistance Decade Box	0.1 ohm to 11,111 ohms	0.05%	Yearly

FIG. 2. OVER-ALL VIEW of AiResearch Standards Laboratory shows a standard voltmeter (foreground) being standardized by means of an L&N K2 potentiometer and standard cell.

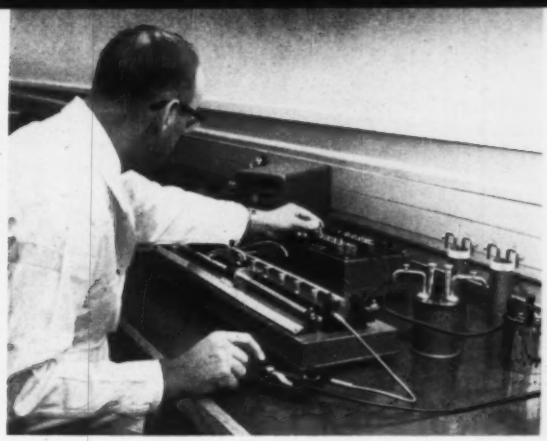

FIG. 3. DOUBLE KELVIN BRIDGE in use by author for measurement of low resistance.

sonnel that handle the equipment. The periodic calibration intervals specified herein have been determined by previous experience with instruments of this type.

The periods of calibration are frequent; this was done intentionally in order to build up a case history for each instrument. Time and experience will establish more realistic values.

In the interests of expediency and economy, only those items which provide basic reference measurements have been certified by the National Bureau of Standards. Only those standards whose basic accuracies can be certified by the N. B. S. have been included.

Provisions for maintaining basic mechanical reference standards have not been included, but the need for reference mechanical standards cannot be overemphasized if a high degree of accuracy is to be maintained throughout the plant.

Every effort has been made to reference all standards contained herein against the measurements of the base quantities of length, mass, and time.

The following tables show the relationship between Reference Standards (Primary Instruments) and Working Standards (Secondary Instruments).

Note designations: I—Instrumentation Laboratory
M—Maintenance Laboratory
L&N—Leeds & Northrup
G-R—General Radio
GE—General Electric
C-D—Cornell-Dubilier
Aminco—American Instrument Co.
Cenco—Central Scientific Co.
W&T—Wallace & Tiernan
F&P—Fischer & Porter
A-B—Allen-Bradley

Table 9—Standards of AC and DC Resistance Secondary Standards Laboratory

QUANTITY AND CODE	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1 M	Shallcross Resistance Box	0 +10 Meg	0.1%	180 days
1 M	L&N Anthony Pattern Bridge No. 4230	0-111,111 ohms	0.03%	Yearly
1 M	G-R 1432 Decade Resistor	0.1-10,000 ohms	0.05%	180 days
1 M	Shallcross Decade Resistor No. 833	0-10 Meg	1/10%	180 days
1 M	L&N Precision Voltage Divider	1-100,000 ohms	±0.10%	180 days
2 M	L&N Precision Resistor 4223-B	0.001 ohm	0.02%	180 days
2 M	L&N Precision Resistor 4222	0.01 ohm	0.02%	180 days
2 M	L&N Precision Resistor 4221	0.1 ohm	0.02%	180 days
2 M	L&N Precision Resistor 4020	1 ohm	0.01%	180 days
2 M	L&N Precision Resistors 4025-B	10 ohms	0.01%	180 days
2 M	L&N Precision Resistors 4030-B	100 ohms	0.01%	180 days
2 M	L&N Precision Resistors 4035-B	1000 ohms	0.01%	180 days
2 M	L&N Precision Resistors 4040-B	10,000 ohms	0.01%	180 days
1 1	G-R Decade Resistor Model 1432N	0.1 ohm to 11,111 ohms	0.05%	180 days
1 1	G-R Decade Resistor Model 1432P	10-1,111,100 ohms	0.05%	180 days
1 1	Shallcross No. 825 Resistance Box	0-11,110 ohms	0.1%	180 days
1 1	Rubicon No. 1040 Wheatstone Bridge	0.001 to 10 Meg	0.05%	180 days
1 1	Shallcross No. 543 Resistance Box	0-1 ohm	0.25%	180 days

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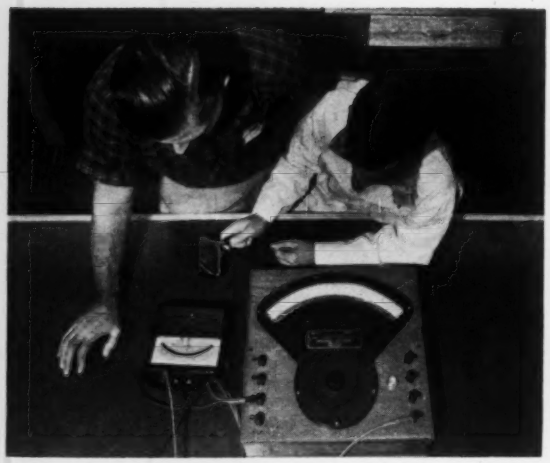


FIG. 5. STANDARDIZING a voltmeter using a high-accuracy laboratory standard.

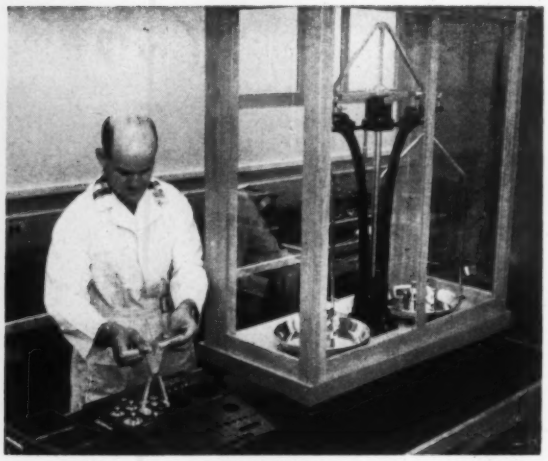


FIG. 6. CALIBRATING units of mass.

Table 10—Standards of Capacitance Primary Standards Laboratory

QUANTITY	OR ACCESSORY STANDARD	RANGE	ACCURACY	CAL. PERIOD
1	L&N 1091 Standard Capacitance	1-11 Mfd in steps of 0.001 Mfd	0.1%	Yearly
1	G-R 722D Precision Capacitor with Worm Correction	100-1150 Mmf 25-100 Mmf	0.1%	Yearly
1	Comparison Oscillator			
1	G-R 716C Capitance Bridge with Worm Correction	100 Mmf to 1 Mfd, 100 Mmf to 1150 Mmf	0.1%	Yearly
1	G-R 1409-F Precision Capacitor	0.001 Mfd	0.1%	Yearly
1	G-R 1409-G Precision Capacitor	0.002 Mfd	0.1%	Yearly
1	G-R 1409-K Precision Capacitor	0.005 Mfd	0.1%	Yearly
1	G-R 1409-L Precision Capacitor	0.01 Mfd	0.1%	Yearly
1	G-R 1409-M Precision Capacitor	0.02 Mfd	0.1%	Yearly
1	G-R 1409-R Precision Capacitor	0.05 Mfd	0.1%	Yearly
1	G-R 1409-T Precision Capacitor	0.1 Mfd	0.1%	Yearly
1	G-R 1409-U Precision Capacitor	0.2 Mfd	0.1%	Yearly
1	G-R 1409-X Precision Capacitor	0.5 Mfd	0.1%	Yearly
1	G-R 1409-Y Precision Capacitor	1. Mfd	0.1%	Yearly
1	G-R 1212-A Null Detector			
1	G-R 1203-A Power Supply			
1	G-R 1951-A Filter			

Table 11—Standards of Capacitance Secondary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1 M	G-R 650P1 General Purpose Bridge	1 Mmf-100 Mfds	1%	180 days
2 M	G-R 509F Standard Capacitor	0.001 Mfd	0.1%	Yearly
2 M	G-R 509K Standard Capacitor	0.005 Mfd	0.1%	Yearly
2 M	G-R 509L Standard Capacitor	0.01 Mfd	0.1%	Yearly
2 M	G-R 509R Standard Capacitor	0.05 Mfd	0.1%	Yearly
2 M	G-R 509T Standard Capacitor	0.1 Mfd	0.1%	Yearly
2 M	G-R 509U Standard Capacitor	0.2 Mfd	0.1%	Yearly
4 M	G-R 509Y Standard Capacitor	1 Mfd	0.1%	Yearly
1 1	G-R 1428B Standard Capacitor	22 Mmf 1100 Mmf ±5 Mmf	±1%	180 days
1 1	G-R 219K Standard Capacitor	1.110 Mfd in 0.001 steps	1%	180 days
1 1	C-D Decade Capacitor CDB3	0-1 Mfd 0-0.1 Mfd	10%	180 days
1 1	C-D Decade Capacitor CDC3	0-10 Mfd 0-0.01 Mfd	10%	180 days
1 1	C-D Decade Capacitor CDA5	0-0.0001	10%	180 days

Table 12—Standards of Inductance Primary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1	G-R 667-A Inductance Bridge	0.1 microhenry to 1 henry	0.2% +0.1 microhenry	Yearly
1	G-R 1482B Standard Inductor	100 microhenry	0.05%	Yearly
1	G-R 1482C Standard Inductor	200 microhenry	0.05%	Yearly
1	G-R 1482D Standard Inductor	500 microhenry	0.05%	Yearly
1	G-R 1482E Standard Inductor	1 millihenry	0.05%	Yearly
1	G-R 1482F Standard Inductor	2 millihenry	0.05%	Yearly
1	G-R 1482G Standard Inductor	5 millihenry	0.05%	Yearly
1	G-R 1482H Standard Inductor	10 millihenry	0.03%	Yearly
1	G-R 1482J Standard Inductor	20 millihenry	0.03%	Yearly
1	G-R 1482K Standard Inductor	50 millihenry	0.03%	Yearly
1	G-R 1482L Standard Inductor	100 millihenry	0.03%	Yearly
1	G-R 1482M Standard Inductor	200 millihenry	0.03%	Yearly
1	G-R 1482N Standard Inductor	500 millihenry	0.03%	Yearly
1	G-R 1482P Standard Inductor	1 henry	0.03%	Yearly
1	G-R 1482Q Standard Inductor	2 henry	0.03%	Yearly
1	G-R 1482R Standard Inductor	5 henry	0.05%	Yearly
1	G-R 1482T Standard Inductor	10 henry	0.05%	Yearly

Tabel 13—Standards of Inductance Secondary Standards Laboratory

QUANTITY AND CODE	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1 M	G-R 106-L Standard Inductors	0.1 Mh	0.1%	Yearly
1 M	G-R 1482-B Standard Inductors	100 Mh	¼%	Yearly
1 M	G-R 106G Standard Inductors	1 Mh	0.1%	Yearly
1	G-R 1482E Standard Inductors	1 Mh	0.1%	Yearly
1	G-R 106-J Standard Inductor	10 Mh	0.1%	Yearly
1	G-R 1482-H Standard Inductor	10 Mh	0.1%	Yearly
1	G-R 106K Standard Inductor	100 Mh	0.1%	Yearly
1	G-R 1482L Standard Inductor	100 Mh	0.1%	Yearly
2 M	G-R 107K Standard Inductor	25-500 Mh	2.5%	Yearly
1 M	G-R 106-M Standard Inductor	1 henry	0.1%	Yearly
1 M	G-R 1482-P Standard Inductor	1 henry	0.1%	Yearly
4 M	G-R 1481-M Standard Inductor	5 henry	¼%	Yearly
1 1	G-R 1490-B Decade Inductor	0.001-11.11 henry	2% 0.25%	Yearly

Table 14—Standards of Electrical Power AC Primary Standard Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1	Weston 326 Primary Standard Wattmeter single phase	300/150/75V max 5/2.5 amps Norm 1500/750/375/187.5 watts	0.1%	Yearly
1	Weston 327 Current Transformer Type II	1200/600/400/300/200/100/50/20/10		Yearly

Table 15—Standards of Power AC Secondary Standards Laboratory

QUANTITY AND CODE	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
2 M	Esterline-Angus Recording Wattmeters	0-1 KW	1%	180 days
1 1	Weston 329 Polyphase Wattmeter	0-1 KW	½%	90 days
1 1	Weston 432 single phase Wattmeter	0-30	½%	90 days

Table 16—Standards of Temperature Primary Standards Laboratory

QUANTITY AND CODE	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1	L&N Platinum vs. Platinum-10%-Rhodium Thermocouple	32F to 2650F 0 to 1455C	0.5C°	Yearly
1	L&N CF19 Equalizing Block			
1	Reference Junction Distilled Ice Bath	+OC	Abs	
1	L&N K3 Potentiometer	0-1.611 Volts	0.015% average +2 microvolts	Yearly
1	L&N 9003 Checking Furnace and Controller	300-1800F		
1	L&N Platinum Resistance Thermometer (used with Mueller Bridge)	—190 + 500C (—310F-+932F)	0.01C°	Yearly
1	Hypsometer	100C	Abs	
1	L&N 8067 Mueller Bridge	0-81.111 ohms	0.02C°	Yearly
1	L&N 8068 Commutator			Yearly
1	L&N 2284D Galvanometer			
1	L&N 2100 Lamp and Scale			
1	Set Precision Thermometers Tag No. 51344	—36-+760F	0.1-0.5 F°	Semi-yearly
1	Hallikainen Type 1132A Constant Temperature Bath With Controller	50-500F	0.005F°	Yearly
1	Precision Thermometer No. 51199	—150 to 120F	0.1F°	Semi-Yearly

Table 17—Standards of Temperature Secondary Standards Laboratory

QUANTITY AND CODE	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1 M	Set Taylor ASTM-68F Thermometers		0.5%	180 days
1 M	L&N K 2009-30-18S Standard Thermocouple			180 days
2 M	L&N 8662 Millivolt Bridges	0-16 mv 0-80 mv	±0.05 mv	Yearly
1 M	Taylor ASTM Thermometers (Set)	—150-120F	0.2F°	180 days
1 M	Carbohm Coil			6 Months
3 1	L&N 7552 Precision Potentiometer			Yearly
2 1	L&N No. 8662 Precision Potentiometers			Yearly
1 1	Hypsometer (AiResearch fabricated)	210.6 F		
1 1	Braun No. 82 Thermocouple Furnace	0—2000 F		
2 1	Eppley Lab Standard Cells		0.01% Abs	Yearly
5 1	Standard Thermometers	—5 to 60 C 48 to 102 C 93 to 152 C 148 to 202 C 200 to 360 C		90 days
1 1	L&N 8710-2009-24 Platinum vs. Platinum-10%-Rhodium Thermocouples	1200 —1400 F 1600 —1800 F 2000 F	2 F° 3 F° 1 F°	Yearly

Table 18—Standards of Weights and Measures Primary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1	Ainsworth TC Analytical Balance	200 grms	sens 1/40 mg	
1	Set of Class S Weights for Above	0-200 grms	Class S	N.B.S. Yearly
1	August Sauter High Capacity Precision Balance	200 grms to 20 Kg	Sens 50 mg	
1	Set of Class S Weights	50 mg to 20 Kg	Class S	N.B.S. Yearly

Table 19—Standards of Weights and Measures Secondary Standards Laboratory

QUANTITY AND CODE	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1 M	Standard Weight Set Howe	1-50 lbs		Yearly
2 1	Sets Standard Weights	1-2-5-10		Yearly
2 M	Standard Weights Howe	25-50 lbs		Yearly
9 M	Standard Weights Howe	50 lbs		Yearly
1 M	Standard Weights Howe	25 lbs		Yearly
1 M	Standard Weights Howe	5 lbs		Yearly
2 M	Standard Weights Howe	2 lbs		Yearly
1 M	Standard Weights Howe	1 lb		Yearly
1 M	Set Weights	1/16 oz 2 lbs		Yearly
1 1	Welch Balance Scale			
1 1	Set (Seko) Weights Seeder Kohlrusch	5-10-20-100 200-300 500 mg 1-2-3-5-10 20-30-50-100 grms		Yearly
1 1	Set Howe Weights	3-1 lb 1-25 lb 6-10 lb 2-5 lb 2-2 lb 4-50 lb		Yearly
1 1	Set Stansi Products Brass Weights	1-2-5-10-20-50-100-200-500-1000-2000 grms		Yearly
1 1	Set Ohaus Brass Weights	2-5-10-20-50-100-200-500 1000 grms		Yearly
1 1	Set Ohaus Sto A Weigh Weights	1-2-5-10-20-50-100-200-500 grms		Yearly

Table 20—Standards of Pressure and Vacuum Primary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1	Aminco 47-2220 Pressure Balance with Hand Operated Generator	35-20,000 lb	Bore 0.00001" Weights Class S. 0.1% min.	N.B.S. Bi-yearly
1	Ideal Arrowsmith 10-61-30 U Tube, Manual, Barometer Manometer With Null Balance Indicator	0-30" Hg	0.005"	N.B.S. Initially
1	Welch 1392 Duo Seal Vacuum Pump with Oil Diffusion Pump	1 x 10^{-6} Hg	0.013"	
1	Ideal Arrowsmith 10-61-100 U Tube, Manual Barometer with Null Balance Indicator	0-100" Hg		N.B.S. Initially
1	Cenco 94210 Surface Plate			
1	Cenco 94214 Bell Jar With Gasket			
1	McLeod Gauge Kontes Glass Company	0.005 to 1000 microns Hg		

Table 21—Standards of Pressure and Vacuum Secondary Standards Laboratory

QUANTITY AND CODE	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1 M	Ashcroft 1300 Dead Weight Tester	0-500 psi	1/10%	Yearly
1 M	Ashcroft 1313A Dead Weight Tester	50-10,000 psi	1/10%	Yearly
1 1	W&T FA-187 Precision Manometer	0-30" Hg		Daily
1 M	Crosby Dead Weight Tester	0-4000 psi	1/4%	Yearly
1 M	Laboratory Test Gauge	0-2000 psi	0.1%	90 days
1 M	Laboratory Test Gauge Ashcroft 1332	0-15 0-30 0-60 0-100 psi	1/4%	90 days
1 M	Vacuum Gage Tester	0-30" Hg	1/4%	Yearly
2 1	Amthor 470 Dead Weight Testers	0-10,000 psi	1/4%	Yearly
2 1	Amthor 460 Dead Weight Testers	0-500 psi	1/4%	Yearly

Table 22—Standards of Pressure and Vacuum Secondary Standards Laboratory

QUANTITY AND CODE	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1 1	W&T 1 5487 Barometer	28-31" Hg		Yearly
1 1	Henry Green 832 Recording Barometer	28-31" Hg		180 days
2 1	Heise H 8816 Pressure gauges	0-600 psi		90 days
2 1	Heise H 8816 Pressure gauges	0-30 psi		90 days
2 1	Heise H 8816 Pressure gauges	0-100 psi		90 days
1 1	Stokes 276aC McLeod gauge	0-5000 microns		Yearly
1 1	Cenco 94151 McLeod gauge	0.5 to 1600 microns		Yearly

Table 23—Standards of Length Primary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1	Invar Standard Scale Gaertner No. M 1004	1 Meter	0.001 mm	Yearly
1	Filar micrometer microscope with illuminator and support stand.			

Table 24—Standards of Acoustics Primary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1	Precision Potentiometer Bruel and Kjaer (Denmark)			180 days
1	Baby Dead Room			
1	Brush Condenser Microphone type 411 with Accessories Bruel and Kjaer (Denmark)	20-16000 cps	±2 db	180 days
1	Brush Microphone Calibration Apparatus Type 4120 Bruel and Kjaer (Denmark)		½ db*	180 days
	*Note: When the above equipment is operated as a system, the over-all accuracy of calibration is calculated to be with 0.5 decibels absolute.			

Table 25—Standards of Flow Primary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1	Standard graduate	2000 mm	0.05%	
2	Standard Metric Flowmeters			

Table 26—Standards of Flow Secondary Standards Laboratory

QUANTITY AND CODE	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL PERIOD
1 1	F&P 5165-210 Rotameter	0-1 gal/min	½%	180 days
1 1	F&P 5165-210 Rotameter	0-1 gal/min	½%	180 days
1 1	F&P 5165-211 Rotameter	0-1 gal/min	½%	180 days

Table 27—Standards of Vibration Primary Standards Laboratory

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1	Gaertner 561P-517K Gathetometer and Microscope	0-2"		Yearly

Table 28—General Equipment

QUANTITY	STANDARD OR ACCESSORY	RANGE	ACCURACY	CAL. PERIOD
1	H-P 400 H Vacuum Tube Voltmeter	0-300 V AC	2%	
1	H-P 202 C Oscillator	1-2 x 10^{-5} cps	2%	
1	Welch 1392A Duo Seal Mechanical and Diffusion Pump Assembly	1 x 10^{-6} mm Hg		
1	Sorensen 1000 BB Power Supply for Rack Mounting	200-1000 V DC at 500 ma	0.5% Reg.	
1	Sorensen 325 BB Power Supply for Rack Mounting	0-325 V DC at 125 ma	0.5% Reg.	
1	Sorensen Type 1E Single Phase Rack Mounted Regulator	1500 watts		
3	Powerstat UCIM Variable Transformers			
1	Weston 2201 Relative Humidity Indicator			
2	Jagabi Variable Resistors Type 10-250 watts	0.06-6 ohms		
2	Jagabi Variable Resistors Type 30 1500 watts	0.01-2 ohms		
2	Jagabi Variable Resistors Type			
1	Power Cart DC with Charger (4 nicad batteries)	24 V		
1	John Fluke DC Precision Power Supply Model 301-c	1.02 — 1012 V	0.01%	
1	Precision AC Power Supply	0-3000 V		
1	G-R Model 1800B VTVM	0.1-150 V AC 0.01-150 V DC		
1	A-B Compression rheostat 4800 watts			
1	Jagabi 1479-1 Compression Rheostat	4 amps, 3600 ohms		
1	Jagabi 1416-1 Compression Rheostat	25 amps, 1.7 ohms		
1	Jagabi 1412-11, Type U Compression Rheostat	12 amps, 8.9 ohms		
1	Jagabi 1463-1 Compression Rheostat	2 amps, 300 ohms		

Curves For Finding Damping Ratio and Resonant Gain of Second-Order Systems

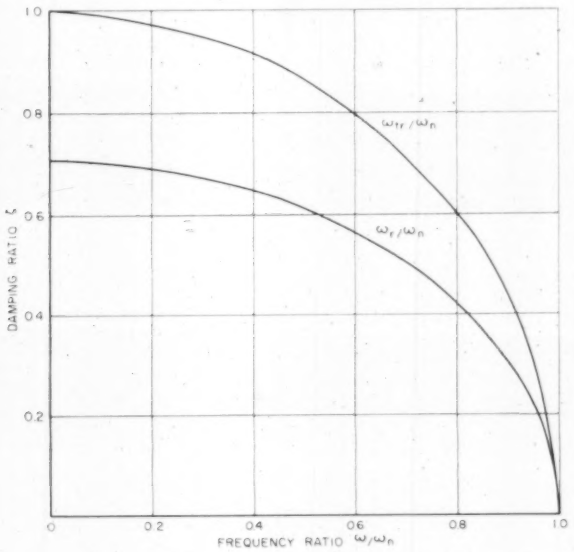


FIG. 1. CURVES for finding damping ratio from frequency ratio.

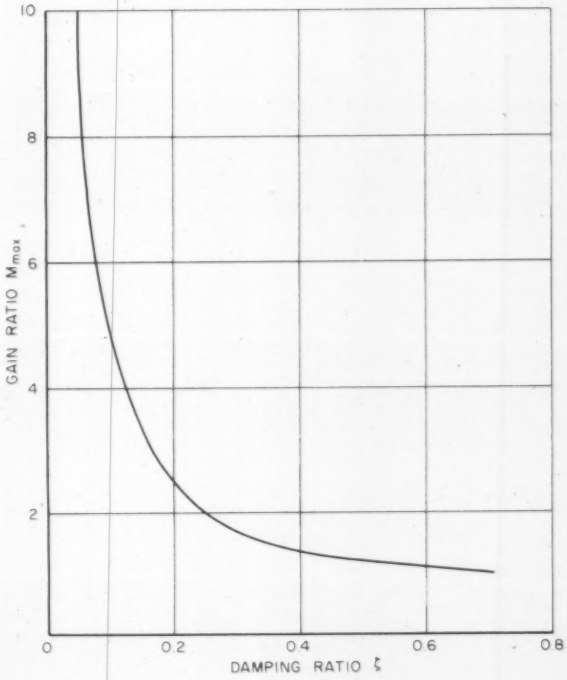


FIG. 2. CURVE for finding maximum gain from damping ratio.

These curves permit quick determination of damping ratio and resonant gain of second-order systems, and should find wide application as many control systems can be adequately approximated by a second-order characteristic equation.

LESLIE R. AXELROD

Cook Electric Co.

SECOND-ORDER SYSTEMS can be characterized by their damping ratio ζ and undamped natural frequency ω_n. In a previous paper[1] the author has presented a nomogram for estimating ω_n; the primary concern of this article is a means of finding ζ.

From transient studies it is possible to measure the system's frequency of oscillation ω_{tr}. Equation (1) relates ω_{tr} and ω_n, as follows[2]:

$$\omega_{tr}/\omega_n = \sqrt{1 - 2\zeta^2} \qquad (1)$$

Frequency-response tests yield the resonant frequency (ω_r) at which the system has maximum gain (M_{max}). Equation (2) relates ω_r and ω_n:

$$\omega_r/\omega_n = \sqrt{1 - \zeta^2} \qquad (2)$$

Thus, if ω_n is known, ζ can be found from either transient or frequency-response measurements. The curves of Fig. 1 provide a quick graphical solution of equations (1) and (2) for the damping ratio.

The maximum gain M_{max} is a function[2] only of ζ:

$$M_{max} = \tfrac{1}{2}\,\zeta\sqrt{1 - \zeta^2} \qquad (3)$$

The curve of Fig. 2 permits rapid solution of equation (3).

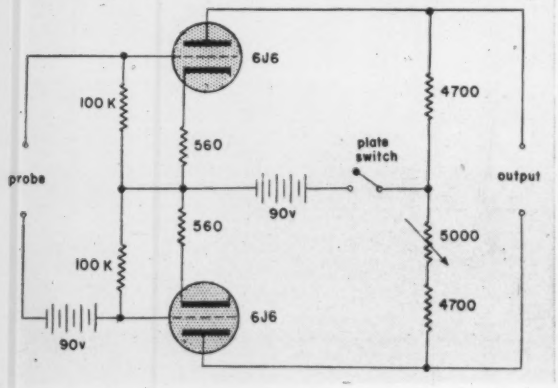
[1]Leslie R. Axelrod, "Finding Natural Frequency Quickly," *Instruments and Automation*, Oct., 1957.

[2]John D. Trimmer, *Response of Physical Systems*, John Wiley Sons, Inc. New York, 1950.

FLAME DETECTOR

Presence of a flame is detected by this simple push-pull-amplifier circuit, using a probe located in the flame. When the flame is burning, presence of ions in the gas stream lowers the resistance between two wires placed in the flame path—or between one wire and the burner.

When the flame is out, the two halves of the 6J6 dual triode are balanced to equal plate voltage by means of the 5000-ohm potentiometer, and there is no output signal. Presence of flame introduces a resistance of 1 to 30 megohms, depending on combustion characteristics, in series with the 90-v bias battery. This produces a grid-



to-grid potential which unbalances the plate currents of the two tube sections, producing output voltage of as high as 40 v (into a high impedance indicator).

An additional stage could be used to operate a relay for flame failure alarm. Relay should be connected for fail-safe operation.

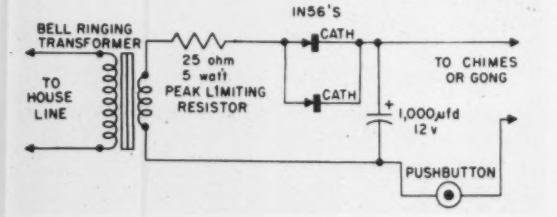
B Supply: 90 v dc at 20 ma; 90 v bias battery (at negligible drain) also required.

Source: Donald P. Duclos and William M. Grounds, Dept. of Mechanical Engineering, Northwestern University, Evanston, Ill.

CAPACITOR DISCHARGE BOOSTS SOUND LEVEL OF DOOR CHIME

A capacitor-charging circuit can be used to obtain greater audible output from door chimes or single-stroke gongs; circuit is similar to one used for magnetizing (*I&A*, April, 1956).

Conventional doorbell transformer is used with germanium diode rectifiers to charge a 1000-uf capacitor to 12-v dc. When pushbutton is pressed, capacitor is discharged through the gong. Conventional doorbell trans-



formers deliver 12, 16 or 24 v. The 12- or 16-v types require only one type 1N56 crystal; with 24-v transformers two crystals in parallel should be used to keep peak diode current well below the 1-ampere maximum rating. The 25-ohm resistor limits maximum current.

Source: Booklet *Electronic Shortcuts for Hobbyists*, Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.

ELECTRONIC

CHARLES F. KEZER

Digitronics Corp.

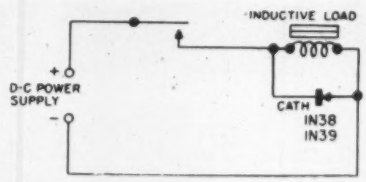
and

MILTON H. ARONSON

Instruments & Automation

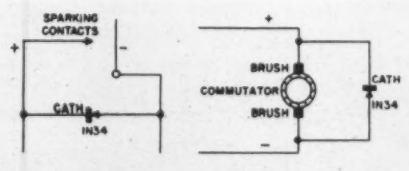
SPARK SUPPRESSOR CIRCUIT PROTECTS SWITCH CONTACTS IN INDUCTIVE CIRCUITS

When current is interrupted in an inductive circuit such as a d-c relay coil or d-c solenoid, the large rate of change of current produces a very high emf across the switch contacts. Resultant sparking and pitting of the switch contacts can produce r-f interference and substantially shorten switch life. As the polarity of the generated counter-emf is always such as to tend to continue flow of current, it is always opposite to that of the applied voltage. Hence a diode rectifier connected *across* the inductive circuit as shown can shunt out the *counter-emf* without affecting normal operation.



The 1N34, 1N38, or 1N39 diode or equivalent is usually satisfactory; the back-voltage rating of the crystal *must* be greater than the applied signal. In obstinate cases, the 1N56 diode may prove superior because of its higher conductivity. Two or more diodes connected in parallel will increase the quenching action.

Rectifiers also can be placed directly across sparking contact or across the brushes of a motor, as shown, to suppress sparking.



(A) MAKE-AND-BREAK CONTACTS (B) COMMUTATOR OF dc MOTOR

Source: Booklet, *Electronic Shortcuts for Hobbyists*, Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.

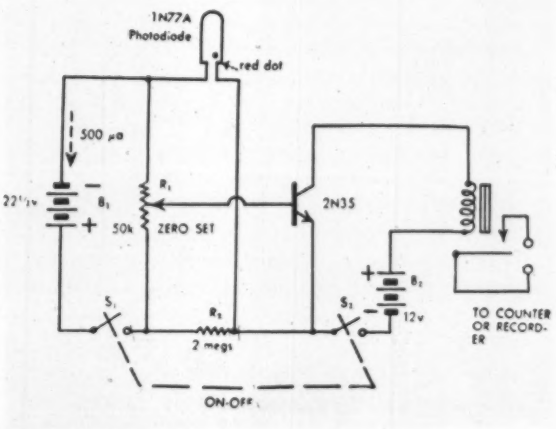
CIRCUITRY

The circuit is the heart of all electronics. Here are 6 more basic and interesting circuits. Unless marked, resistors are in ohms, capacitors in microfarads.

PHOTOELECTRIC DETECTOR OPERATES RELAY

A previous circuit (*Sensitive Light Meter*, I&A, Sept., 1957) used a 1N77A photodiode with a transistor current amplifier to drive an indicating meter. In this circuit the indicating meter is replaced by a sensitive relay.

The 1N77A germanium photodiode and the 2-megohm resistor R_2 form two arms of a bridge; the other two are comprised of the two sections of the 50K pontentiometer. Battery B_1 (22½ v) provides the bridge supply voltage. The bridge is balanced, with the photodiode darkened, by adjusting the zero set potentiometer R_1 to obtain



minimum current in the relay winding. Under the balanced condition, input current to the 2N35 transistor base is substantially zero. When the transistor is illuminated, its resistance drops, unbalancing the bridge. Base current flows in the transistor, and the resulting collector current closes the relay.

The relay (Sigma type 4F 5000 S) is normally supplied for a 2-ma closure current; in this application it is made more sensitive so that it will close on 1-ma pickup by rotating its spring-tension screw counter clockwise for more sensitive response.

Light sensitivity is sufficient to close the relay on 70 foot-candles at the photodiode. Circuit can be used to detect the passage of objects between a light source and the photodiode. In this application the relay is normally closed, opening when the diode is darkened by the passing object. Interchanging the 1N77A photodiode and the resistor R_2 (observing red-dot-positive polarity of the diode) permits operation with the relay normally open, closing when the coil is darkened.

Sensitivity: Relay closes for 70 foot-candles incident light.

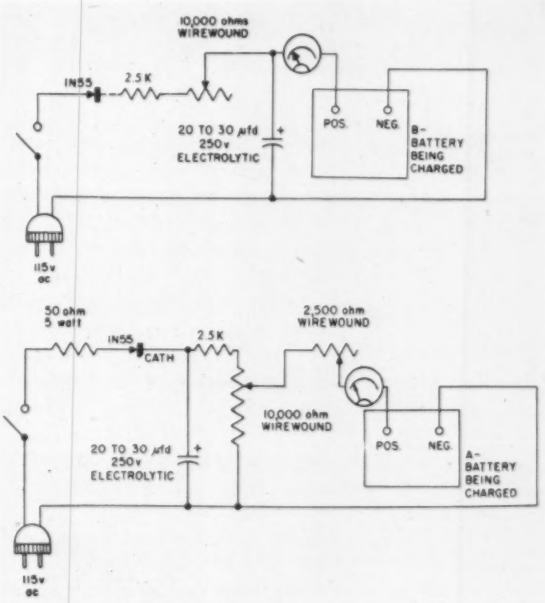
Power supply: 22½ v at 500 microamperes; 12 v dc at 1 ma max.

Source: Booklet, *28 Uses for Junction Transistors*, Sylvania Electric Products, Inc., 1740 Broadway, New York 19, N. Y.

CHARGER FOR SMALL DRY BATTERIES

It is not generally known that dry batteries can be recharged. However, they can be rejuvenated sufficiently for at least one more service period by passing a small direct current through them. Batteries used in portable radios and hearing aids can be recharged with this simple circuit.

A germanium diode is used as a half-wave rectifier, operating directly from the 115-v ac power line. The 1N55 diode is rated at 50 ma continuous current; circuit



should be adjusted with potentiometers to send 5 to 10 ma through the battery.

Length of time required to rejuvenate the battery depends on battery condition; a battery which is burnt out or leaking chemical should be discarded. Some batteries recoup their charge in a few minutes; others may require overnight charging. Discontinue the charging if the battery becomes warm to the touch. As in other transformerless power supplies, there is a shock hazard from any exposed circuit wiring, and proper precautions should be observed.

Source: Booklet, *Electronic Shortcuts for Hobbyists*, Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

FIG. 1. MANY TYPES OF MAGNIFIERS are available.

JOHN F. BRANDT
Bausch & Lomb Optical Co.

HOW TO SELECT

FROM 35 to 40% of all industrial workers do not have adequate vision for their jobs. A good many in that group *do* have normal vision, but there are some jobs in which normal vision is not good vision, such as operations which require steady, close work. There is a big group of workers who do not have adequate vision for their jobs simply because the job requires something beyond the abilities of even good vision.

The eye affords its maximum acuity when the pupil is open to 4 mm (about 5/32″). For ease of seeing, we normally go to a brighter light to examine small detail; this causes our pupils to be temporarily smaller so we cannot see as well, momentarily! Theoretically there is no limit to how small a bright point or line can be seen against a dark background, providing it is bright enough. On the other hand, there are very definite limits to how small a dark line can be seen against a bright background. A dark *point* against a light background has to be even larger.

Something in which the human eye is almost miraculously acute is in detecting whether or not two straight lines are offset one from the other. This shows up in the setting of a micrometer or in reading any vernier and, is technically called "vernier acuity." Psychological effects enter also, because if you set up two exactly similar objects before an observer but make one of them *appear* as if it were further away, the observer can detect smaller detail in the one which appears to be the nearest.

The average human eye can see something if it subtends about one minute of arc. This is about 0.003″ at normal reading distance, or about 0.009″ at arm's length.

In using all tools, it is necessary to select the right one from the many available (Fig. 1)—and use it properly. For much the same reason that you cannot drill a quarter inch hole with a 1/8″ bit, you cannot get a 2″ magnifier which will magnify 10 times. Also, just because a little magnification is good is no sign that a lot of magnification is better. There are cases where a "corrected" magnifier is essential; others in which it is not.

Any lens which increases the *apparent* dimensions of objects seen through it is called a magnifier. This apparent increase can be accomplished by means of a single lens that is thicker at the center than at its edge. In magnifiers this is called a *positive lens.*

Major Considerations

The four major considerations in choosing a magnifier are (1) power, or magnification, (2) working distance, (3) field of view, and (4) depth of field. *When you vary one factor you affect the others.*

In magnifiers, *focal length* and *working distance* are approximately the same. Thus, focal length is roughly the distance between the lens and the object when the image is sharply defined, or "in focus."

The simple formula for determining the power of a magnifying lens is 10 *divided by the focal length*:

$$\text{magnification} = X = 10/f$$

The fact that a little magnification is good is no sign that a lot of magnification is better. Here are the factors that determine how powerful a magnifier to select and when it is needed.

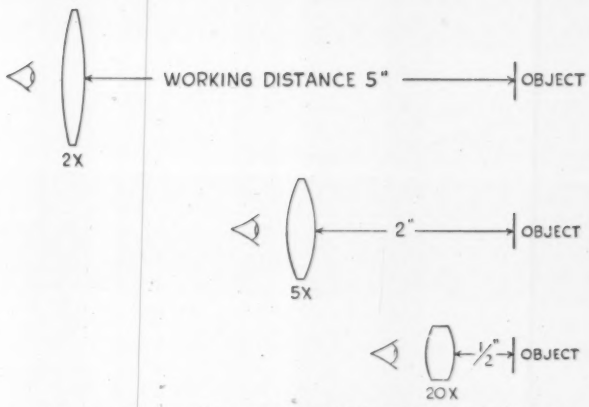


FIG. 2. POWER TIMES WORKING DISTANCE (focal length) = a constant, 10. The higher the power the shorter the working distance and vice versa. An object must be brought to within one-half inch of a 20X lens to be seen clearly.

AND USE INDUSTRIAL MAGNIFIERS

A lens which has a focal length of 5″ is 2X or 2 *power*. Conversely, a lens of 2X has a focal length of 5″ (Fig. 2). Note that *power times working distance* = 10.

In the formula, 10 stands for 10″, the average minimum distance of an object from the "normal" unaided eye. It is the accepted universal standard. Theoretically, according to this standard, at less than 10″, objects cannot be seen distinctly by the unaided eye.

Consider Working Distance First

Suppose you are inspecting a precision machine part which must remain in a lathe fixture during the inspection. The position of the work prohibits bringing the magnifier lens any closer than 3″. Obviously you cannot use a 5X magnifier because it has a *working distance* of only two inches (10 divided by 5″). You must select a lens with a working distance of at least 3″, a 3X lens. For greater working ease and efficiency, an even lower power is advisable. A 2.5X magnifier would result in additional working distance, greater *field of view* and *depth of field*, with little loss of magnification.

Field of View

The third consideration is field of view—the area of the object seen through the magnifier. *The diameter of the field of view of a magnifier is less than its focal length.* We have already found that as the power of a magnifier increases, its working distance decreases. Likewise, as the power increases, the lens diameter—and the field of view—also decreases. One cannot obtain a large-diameter lens (with large field of view) in high-power magnifiers, because the sharpness of curvature of the lens surfaces determines its power.

Consider two spheres of glass, one ¼″ in diameter and the other 2″ (Fig. 4). Spheres are magnifying lenses. The *radius* of the smaller is ⅛ that of the larger. According to a law of optics, the magnification of the smaller sphere is roughly eight times that of the larger. This optical law holds true in spheres of all sizes—to increase the magnification you must decrease the radius, producing a sharper surface curve. As all magnifier lenses are sections of spheres, it becomes obvious that the higher the power the sharper the surface of curvature and, therefore, the smaller the possible lens diameter and smaller the field of view.

For a specific example of how field of view enters into practical use of a magnifier, suppose we are examining the surface of a large casting for imperfections. It might take us hours to cover the entire surface using a 20X glass which has a field of view of little more than ⅜″. If it were necessary to study the nature of imperfections with this high-power magnifier, the proper technique would be first to go over the surface with a wide-field low-power glass, marking questionable areas distinctly, and then inspect with the high-power glass only the marked spots. Thus you cut down inspection time. Fig. 3 shows how the field of view decreases as power increases.

FIG. 3. THE HIGHER THE POWER THE SMALLER the field of view. Illustration at left shows a 6-32 button-head machine screw 1½" long as seen through a 2X magnifier. Working distance is about 5". Illustration at right shows field of view seen by a 10X glass; only a few of the threads are visible; here the lens must be held less than an inch away.

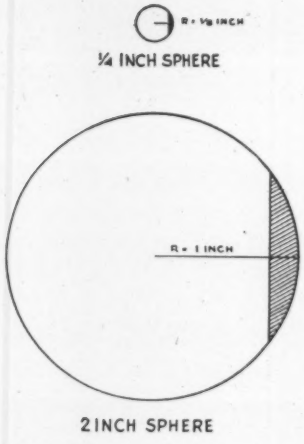


FIG. 4. THE HIGHER THE POWER the smaller the lens. Lens surfaces are sections of spheres—can be pictured as being sliced from a solid ball of glass. In order to get the sharp surface curvature necessary for high magnification, the sphere from which you slice the lens must be small to begin with. The radius of the sphere determines the curvature of the surface and the magnification and maximum size of the lens.

Depth of Field

Depth of field of a magnifier is equal to the distance you can move the magnifier toward or away from an object and still have it in good focus. Beyond these limits the object is said to be "out of focus" and the image is not sharply defined. To hold a 20X magnifier in accurate focus throughout the inspection of a large surface area would be tedious.

Depth of field varies with the power of the lens. It is comparatively great in low-power magnifiers, but shrinks, along with working distance, as the power increases. Focus also becomes more critical and surface contour of the object being viewed becomes more important. For example, the outside diameter of a screw thread might be in focus with a high-power magnifier, the root may not be. (Fig. 5).

The Object

One more factor that should be considered when selecting a magnifier is the *movement* of the object. A lens magnifies speed in the same proportion that it magnifies size. With a 20X lens, for example, the magnified speed of an object on a moving conveyor belt would probably carry it into, and out of, your ¼" field of view before you could examine it. Where extremely high powers are employed, the object and the lens or both should be held fixed.

To sum up rules about magnifiers lenses:

As the power increases—

1. The *working distance* decreases
2. The *lens diameter* decreases
3. The *field of view* decreases
4. The *depth of field* decreases

If you question which of two powers to choose, favor the *lower* of the two. Make it a rule, whenever possible, to forsake magnification in favor of greater working distance, greater depth of field, and wider field of view. You will gain better viewing results.

What is a "Corrected" Lens?

We have been discussing simple lenses only. The quality and results of simple lenses depend on the accuracy of surface curves and the quality of glass used. No matter how well these optical engineering features are developed and combined, all simple lenses are subject to aberrations which degrade or distort the images. These observations include "pincushion" and "barrel" distortions which bend parallel lines and throw edges out of focus.

Corrected magnifiers are those in which deviations have been reduced by arrangements of simple lenses of different kinds of glass into *doublets* or *triplets*. (Fig. 6). In multiple-lens magnifiers, the spacing of the lenses serves to correct for certain aberrations.

Spherical and *Chromatic* aberrations cause other image defects. Spherical aberration is one of the causes of a dull, grey image. Chromatic aberration introduces color fringes so that the image is fuzzy and colors are changed.

Still other aberrations, known as *coma*, *astigmatism*, and *curvature* of field, also contribute to greyness and lack of detail in the outer portions of images. Unfortunately the various lens aberrations seldom exist independently.

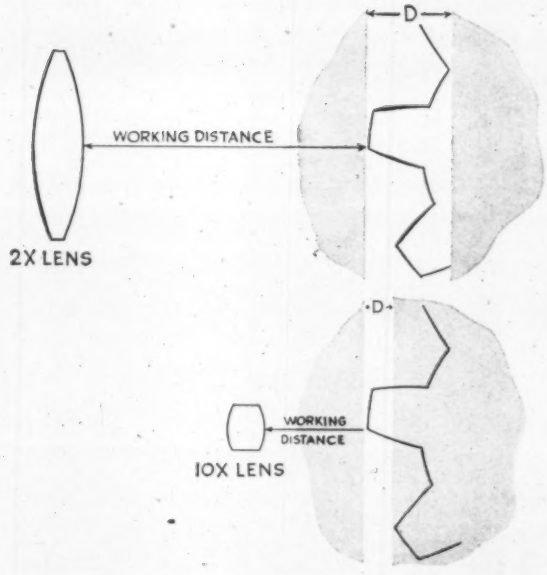


FIG. 5. THE HIGHER THE POWER THE SHALLOWER the depth of field. With a 2X lens the depth of field, D, is considerable—all of the gear tooth is seen clearly at once. With the higher power, D is much less and only a portion of the gear tooth is in focus at one time.

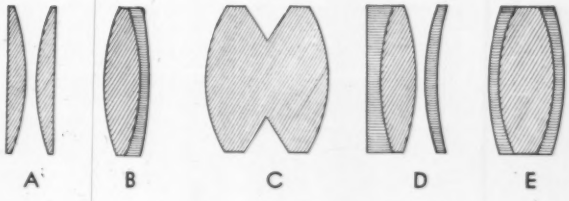


FIG. 6. STANDARD MAGNIFIER LENS SYSTEMS. A shows spaced doublet that achieves limited correction and consists of 2 planoconvex lenses with air space between. B shows cemented doublet, a double convex lens cemented to a plano-concave or meniscus lens—one of crown, the other of flint glass. C shows the coddington—a single lens with a groove diaphragm around its circumference. D shows spaced triplet that combines cemented doublet of plano-concave or meniscus and double convex elements with a single menicus lens. E shows cemented triplet—two meniscus concave elements cemented to a double convex element.

Correction for lens aberrations is achieved by various means. Single lens elements made from different kinds of glass can be combined to form a single compound lens as in the case of the doublet and the triplet. One element will be of crown glass, another of flint glass. One element may be positive in structure, the other negative, to offset the variations of one another. Sometimes a diaphragm in the lens provides correction.

A lens corrected for spherical aberration and coma is called *aplanatic*. A lense corrected for chromatic aberration is called *achromatic*.

Pure White Glass Necessary

All quality magnifier lenses are made from pure white crown glass, ground and polished to standards of precision as high as prescriptive eye glasses. One of the easiest-to-detect characteristics of inferior magnifiers is the green tinge of the glass which produces a hazy image in itself, besides being an indicator of other defects.

What is "Ground and Polished"?

Many inferior lenses are ground and polished after a fashion, but not to the precision finishes required to produce good image quality. Although they can look polished, they still have "ground glass" surfaces which degrade the image, or non-spherical surfaces which produce image jump. Crude methods of manufacture do permit low prices, but the resulting products actually are contrary to the purpose of magnifiers—to allow you to see better.

Quality magnifier lenses are ground and polished to match a prescribed curve to a tolerance of ±0.0004" while the uniformity of surface is held to within ±0.00006". Such extremes of precision are necessary to obtain superb image quality. The table shows standard lenses available commercially.

Table 1—Standard Lenses Available Commercially
(courtesy Bausch & Lomb)

POWER	LENS SIZE 2"	1⅝"	1½"	1¼"	1"	¾"	⅝"	½"	⅜"
2X	X				X				
2.5X					X				
3X	X		X		X		X		
3.3X					X				
3.5X		X		X					
4X			X		X				
4.5X			X						
5X				X	X	X			
6X				X					
7X					X				
7.5X					X				
8X					X	X			
10X					X		X	X	X
13X								X	
14X						X		X	
15X								X	
16X								X	
18X								X	
20X								X	X

Journal of the S C M A . . .

SOUTHERN CALIFORNIA METER ASSOCIATION

President: *Richmond M. Voils, Jr.*
Vice-President: *F. Ed Funke*
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Auditor: *John M. Quirk*
Program Chairman: *Martin E. Kantor*

PROBLEM: How to rationalize a supply of gas that is constant throughout the year with a demand that is seven times greater in the winter than in the summer?

SOLUTION: Interruptible sales plus underground gas storage. The underground reservoir can store gas and supply oil at the same time.

SCMA MEMBERS look at telemetering board at Playa del Rey as guide Bill Clarke (left) explains the remote control of the del Rey facility.

Playa del Rey
Underground Gas Storage

ED DUFFY ● Southern California Gas Co.

A CLASSIC example of the ancient adage, "Necessity is the mother of invention," is presented in the Playa del Rey underground storage project of the Southern California Gas Company.

This $15 million subterranean facility is the newest of four major natural gas "savings banks" which have been developed during the last 16 years in California's heavily populated Southland.

These fields—like some 200 others throughout the nation—are depleted oil fields into which vast quantities of natural gas are pumped during "off peak" periods. The reservoirs then provide a nearby source of natural gas to meet seasonal, as well as hourly, peak demands by customers.

In Southern California the method has been so successful that the acquisition of additional fields is planned as they become available.

Soaring Demand is Irregular

To meet the soaring gas supply needs of their Southland customers, Southern California Gas Company and Southern Counties Gas Company utilized all available California sources of natural gas and still found it necessary to contract for large volumes of gas from out-of-state. The two gas companies have well over 2 million customers, and during the winter peak-season the average customer uses *seven times* as much gas on a cold day as on a summer day. As the flow of gas from California and mid-continent sources into the Southland distribution centers arrives at a nearly constant rate—summer and winter—it is obvious that the unused gas arriving during the summer must be stored in a manner to make it easily accessible during the heavy-demand winter months.

Interruptible Gas Sales

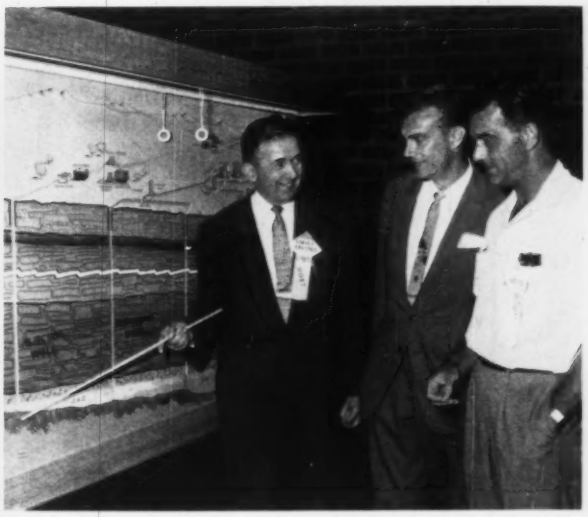
To meet this situation, the gas companies have set up a system of "interruptible" gas sales to industrial plants. Thus, they balance their loads throughout the year largely by supplying great volumes of gas for all sorts of industrial uses on contracts that provide for

December Meeting: Thursday, the 19th, Rio Hondo Country Club, Downey, California.

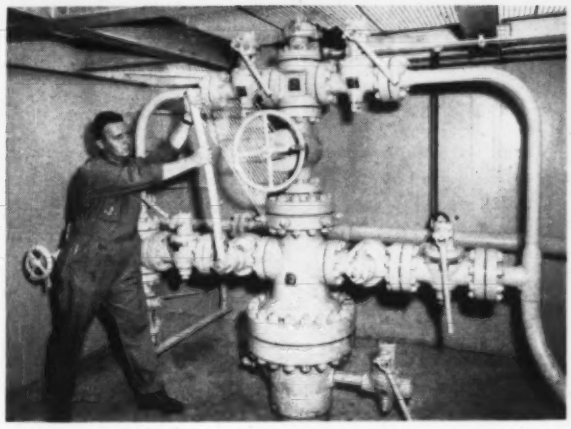
Feature: Past President's Night and a feature-length film.

Prepared as a résumé of the information given to members of the Southern California Meter Association during their recent tour of the Southern California Gas Company's Playa del Rey underground storage plant.

J-W combustible gas indicator is explained by tour guide George Griffin (right) to SCMA group.



HARVEY KRAMMES, Southern California Gas Company Superintendent of Transmission, demonstrates function of injection well on illuminated chart to SCMA president Phil Ver Plank (center) and Bob Few.



WELL SURVEY operator Fred Jelly makes periodic check of flowing well located below ground level at Playa del Rey underground storage plant.

interruption in delivery whenever they must have that gas—or system capacity—to meet the needs of domestic, commercial and "firm" industrial users in cold weather. Thus an adequate supply of gas is insured for "firm" users in the winter, and large quantities of gas are made available to industrial "interruptible" users during the off-peak summer months.

Underground Storage

Underground storage is the other—and equally important—method developed by the Southland gas companies to equate this large load differential between warm and cold months.

Sub-surface storage reservoirs, located thousands of feet below the earth, consist of porous stone and sand deposits which can hold large volumes of natural gas under pressure. Most of the underground storage areas formerly held oil in the porous sandstone. As large volumes of gas are received daily from California sources and from the Texas and New Mexico fields, the vital fuel not required to meet customer demands in warm weather months is pumped into these below-surface storage reservoirs.

On the combined systems of the Southern California, Southern Counties and Pacific Lighting Gas Supply companies there are four underground storage projects presently in operation. The largest of these, owned by Pacific Lighting Gas Supply Company, is located at Goleta, a few miles north of Santa Barbara. The working capacity of this huge field is about 14 *billion cubic feet*. Owing to its relatively remote location from the Los Angeles market, and its size, it is primarily used as a means of equating the seasonal supply demand, with gas being stored during the summer and withdrawn during the winter.

In contrast, Playa del Rey is relatively small, with a capacity of about *one-and-one-half billion cubic feet*. But its location, almost in the center of the Southern California market area, makes it an ideal underground holder from which to meet the hourly and daily peak demands.

The Playa del Rey Reservoir

Playa del Rey is particularly important to the gas supply picture in the heavily populated metropolitan area of greater Los Angeles because of the ease and speed with which gas can be delivered into the distribution system. In fact, del Rey gas can be flowing into the gas company's metropolitan system within 30 minutes after it is called for from central dispatching headquarters. This high deliverability characteristic is especially important in equating hourly loads.

Playa del Rey is credited with being the first under-

ground gas storage reservoir in which gas has been stored in a partially depleted oil reservoir with the recovery of large volumes of gas at high rates as the main objective and the recovery of oil as a secondary consideration. This was a pioneering endeavor in that several of the problems encountered were unusual to those of storage in dry gas zones.

History of Playa del Rey

Long before its first use as a storage facility, Playa del Rey was an important oil producing field. The discovery well was completed at 6,194 feet in 1929. An upper zone at 3,905 feet was found the following year and by the end of 1930 there were 141 producing wells in the field.

The Union Oil Company completed a lower zone well south of the original field in May, 1931. This was believed to be an extension of the same field until additional drilling of about 50 wells during 1934 and 1935 indicated this area to be a separate accumulation. This lower field is now the storage zone.

By 1952, however, a new need was becoming increasingly apparent. The rapid increase in industrialization of Southern California during World War II forced upon the local gas companies a number of unanticipated supply problems. It was impossible to build new transmission lines and impractical to add sufficient above-ground storage for peak load requirements.

Realizing the gravity of the situation, the California State Public Utilities Commission, in conjunction with the California State Department of Natural Resources, ordered a study made of the possibilities of underground storage in the Los Angeles Basin.

Report of the study, submitted in July, 1942, covered the southern portion of the lower zone of the Playa del Rey field. Its four major conclusions were (1) the need is critical, (2) the field is suitable and (3) economically feasible, and (4) the National Government should "take over possession or control of the field and so handle it as to make it immediately available as a gas storage project."

Defense Plant Corporation Proves Feasibility

The Defense Plant Corporation of the Federal Government, in the furtherance of the national war effort and acting upon the recommendations of the Army, the War Production Board and the Petroleum Administrator for War, condemned approximately 240 acres of this structure, taking possession in September, 1942. It was transferred to the Reconstruction Finance Corporation in July, 1945.

Using small portable equipment, pilot injection operations were started October 12, 1942, and during the month a maximum volume of 4,151 thousand cubic feet of gas daily was injected into three wells at 162 pounds of pressure. The pilot operation demonstrated that a relatively high injection rate was feasible.

So, starting with a 1,600-horsepower compressor plant the facility was expanded in stages until the injection capacity reached 25 million cubic feet per day with a withdrawal peak of 10 million cubic feet per hour.

Present System

The operation of the field was continued by the Southern California Gas Company under the federal agreement until late in 1953. Then the underground storage facilities and mineral rights to the field were purchased by the company.

Immediately, an expansion and modernization program was put into operation. Included in the project was construction of a new and larger compressor building and office buildings.

This work doubled the withdrawal capacity of the reservoir to 20 million cubic feet an hour and provides for additional increases up to 27 million cubic feet an hour by the winter of 1961-62.

The injection rate has been raised to 100 million cubic feet a day, and can be boosted to 150 million cubic feet with the addition of three more compressors.

Tied to the modernization program of the underground storage facilities was an almost equally important program—from the standpoint of residents of the surrounding area—of beautifying the entire 42.88 acre plant area and all the well sites.

Although this second aim had virtually no effect on the productive capacity of the field, it served to reinforce in the minds of nearby residents one important fact—that the Southern California Gas Company is interested in being a good citizen in the communities it serves and is concerned with the feelings of its neighbors.

The Southern California Gas Company, with an investment of $15 million, has created a reservoir with an underground storage capacity of 1.5 billion cubic feet of gas, practically in the back yard of the community. This is the equivalent of 130 large above-ground gas holders.

Because of the successful operation of this project, the gas users of Los Angeles are assured that when they need it gas is available to them.

Playa del Rey Storage Reservoir

Location	On Santa Monica Bay, two miles south of Venice
Area of station site	42.88 acres
Present working storage capacity	1.5 billion cubic feet
Equivalent above-ground storage	130 large above-ground holders
Number of connected wells	44
Total compressor horsepower	6220
Hourly injection capacity	4 million cubic feet
Hourly withdrawal capacity	10 million c.f. before present expansion 20 million c.f. currently 27 million c.f. ultimately
Investment	$15 million
Depth of storage zone	About 6,000 feet
Present maximum storage pressure	1350 pounds per square inch
Connection with integrated system	Connected with 26 and 30-inch transmission lines at del Rey Junction

Circle 49 on inquiry card.

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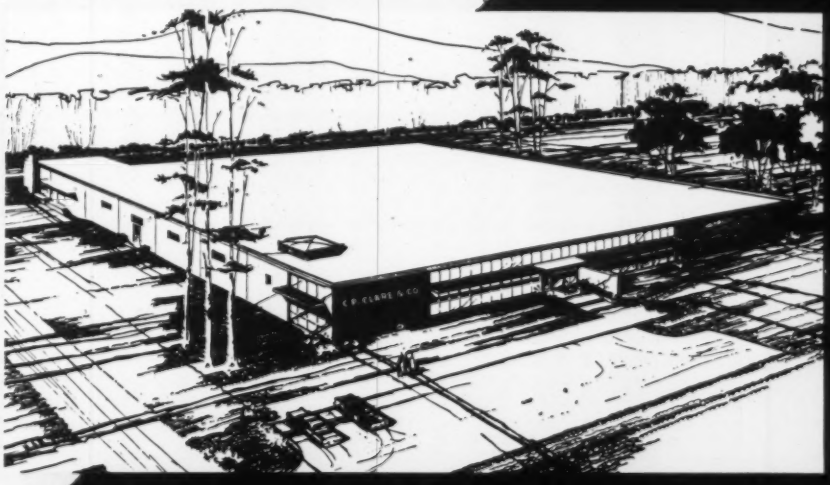

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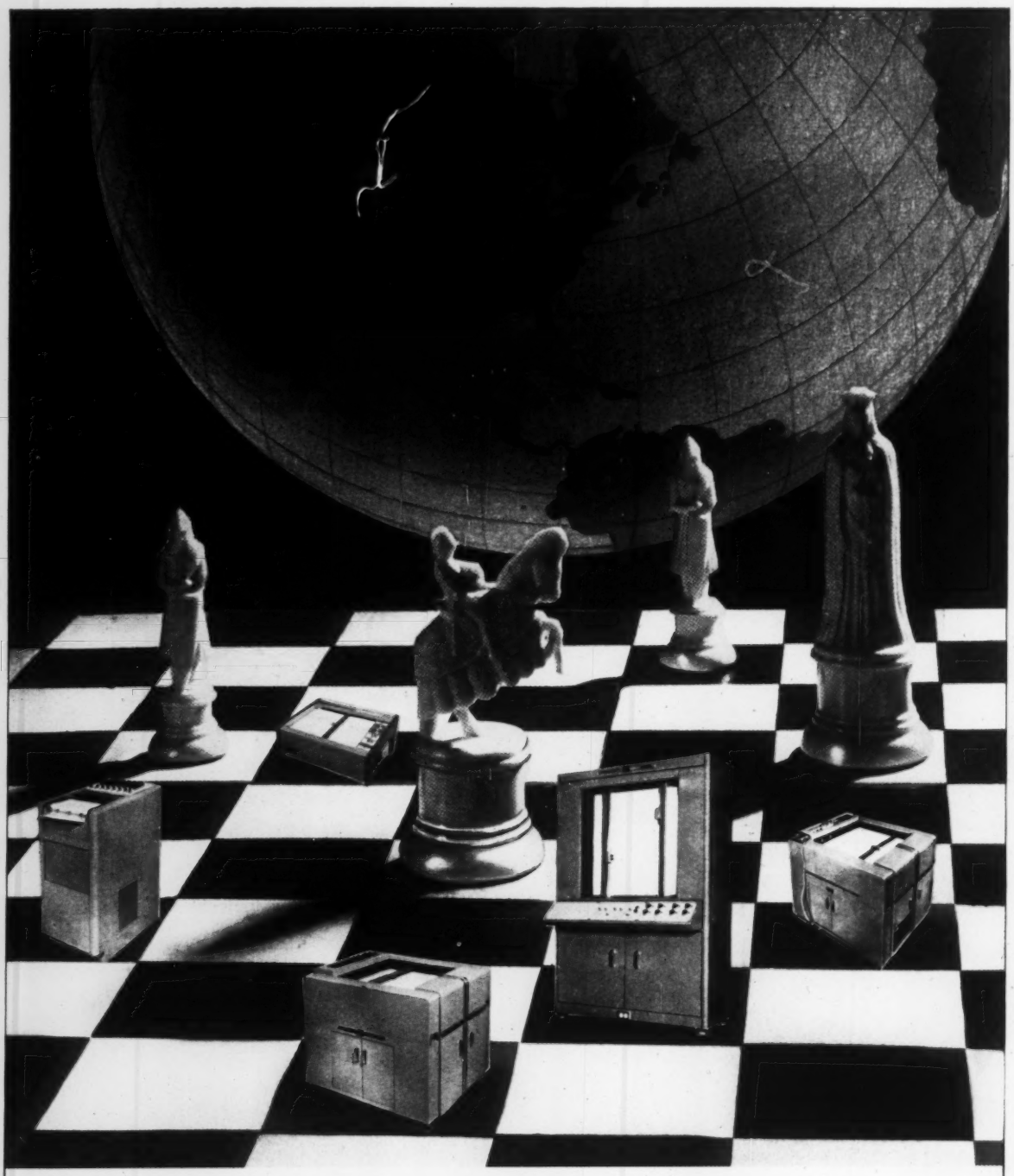

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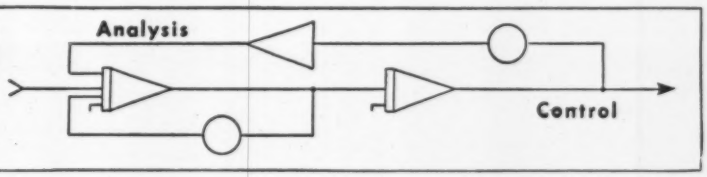

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Suzette McLeod, SECRETARY
8484 LaJolla Shores Drive
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Bits

This month under Pieces we have a condensation of *Ed Holmes'* write-up of the May meeting of the Southeastern Simulation Council, at which papers were presented on "Instrumentation of a Subcritical Reactor" and "Electronic Resolver Circuits."

Under the same heading we also give you *Bill Kindle's* paper, "The Solution of Non-linear Algebraic Equations on an Analog Computer," which he presented at the September meeting of the Western Simulation Council. For the report of the discussion from the floor following Bill's paper we are indebted to *Stan Rogers* (Convair-San Diego, Calif.). *Chuck Walli's* contribution on the same subject is being held pending amplification of his notes.

Under Information (Without Theory) we have an unusual quantity of assorted—or ill-assorted—material, and we close with a Thot, not our own.

Pieces

SE S/C MEETING OF 24 MAY ON "REACTOR INSTRUMENTATION"

More than 20 representatives of nearly a dozen organizations gathered in Gainesville, Florida on 24 May 1957 when the University of Florida was host to the Southeastern Simulation Council.

The meeting was opened by *Dave Prince* (Federal Telecommunication Laboratory, Atlanta, Ga.), Chairman of the SSC, and introductory remarks were made by members of the university faculty. Professor *M. J. Wiggins* spoke on the tour planned for the afternoon; Dr. *H. A. Meyer* of the newly formed computation laboratory described the IBM and other computer facilities; and Dr. *Marion Forsman* told about their nuclear program.

Fagan on Reactor Instrumentation

Professor *W. F. Fagan* then presented his paper entitled "Instrumentation of the Subcritical Reactor." According to Professor Fagan, the analog computer can be a valuable addition to the instrumentation of a nuclear laboratory because the solution of differential equations involving non-linear systems is important in the analytical study of reactor control, and because they can be used for the training of operational personnel as well as the synthesis of new systems.

For instruction in the application of analog computer techniques to nuclear technology, a relatively simple machine is adequate. The University of Florida Nuclear Instrumentation Laboratory staff has been able to use effectively a student-built unit consisting of eight operational amplifiers, an incremental function generator, and a multiplier, together with associated power supplies and static elements. The simulation was good enough to make the students familiar with the general behavior of a complete reactor system, and with more care could be set up to determine the performance of simplified systems.

A critical reactor has a positive temperature coefficient which results in very rapid build-up of neutron flux. It therefore must be moderated by control rods, which, when inserted, diminish the build-up to a value less than critical. Hence a control system which varies the depth of insertion gives complete control of the system.

A sub-critical assembly possesses a negative temperature coefficient. This type is used for instructional purposes to decrease the hazards of student operation. Equations describing the behavior of a reactor are of the form:

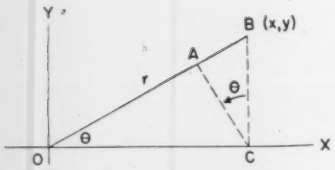

Fig. 1. Coordinate relations.

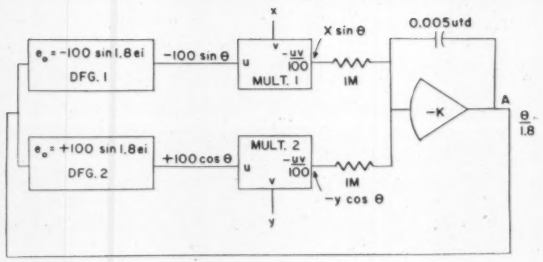

Fig. 2 Complete resolver system.

$$\frac{dn}{dt} = \frac{\delta K - \beta}{l^*} n + \sum_{i=1}^{5} \lambda_i C_i + S$$

and

$$\frac{dC_i}{dt} = \frac{\beta_i n}{l^*} - \lambda_i C_i$$

Professor Fagan indicated diagrammatically a simplified version of a simulator for these equations, then stated that the flux ranges in a practical reactor may change by a factor of as much as 10^{12}. Since the dynamic ranges are so high, only power levels are simulated. Starting levels are very small.

In terms of power, the equations are of the form

$$\frac{dP}{dt} = [\delta - \sum_{i=1}^{5} \beta_i - \alpha(\theta_r - \theta_{r_o}]\frac{P}{T} + \sum_{i=1}^{5} Y_i \lambda_i K_i$$

$$\frac{dK_i}{dt} = -\lambda_i K_i + \frac{\beta_i}{T} P$$

$$b\frac{d\theta_r}{dt} = P - a(\theta_r - \theta_s)$$

$$g\frac{d\theta_s}{dt} = a(\theta_r - \theta_s) - P_o$$

Professor Fagan also showed a block diagram of how the simulator for these equations is connected.

The presentation prompted the following discussion:

Prince: "How is the high dynamic range accommodated?"

Fagan: "The amplifier noise is kept down by using well-filtered supplies and dc filaments."

Prince: "How long are the time constants?"

Fagan: "About 100 cycles."

Lonnie McMillan: (Radiation, Inc., Melbourne, Fla.): "Have you considered transistors?"

Fagan: "Yes; we have also considered the use of logarithmic equations."

C. L. Jordan (Tennessee Eastman Co., Kingsport, Tenn.): "Have you considered the use of low-temperature solid-state amplifiers?"

Fagan: "Not at present. A total of four amplifiers is used. We have had difficulty with stability because the computer is homemade and some of the capacitors are not good."

Prince: "Some laboratories have time-scale changes with automatic devices for changing scales."

Fagan: "Yes, but from an engineering standpoint we do not consider these very elegant.

* * *

Johnson on Resolver Circuits

Robert Johnson presented a paper entitled "Electronic Resolver Circuits." Commenting that in analog computer problems it is often necessary to change coordinates many times in a problem—for example, from polar to cartesian coordinates and back again. Mr. Johnson explained a method for performing this function with basic electronic analog computing equipment.

From Figure 1 we can see that

$$\overline{OA} = x \cos\theta \quad (1)$$
$$\overline{AB} = y \sin\theta \quad (2)$$
$$\overline{AC} = x \sin\theta \quad (3)$$
$$\overline{AC} = y \cos\theta \quad (4)$$

Equations (1) through (4) are valid in all four quadrants. Then from equations (1) and (2):

$$r = \overline{OA} + \overline{AB} = x\cos\theta + y\sin\theta \quad (5)$$

Equations (3) and (4) can be arranged so that

$$\overline{AC} - \overline{AC} = x\sin\theta - y\cos\theta = 0 \quad (6)$$

If (6) is satisfied, then for

$$-\pi \leqslant \theta \leqslant +\pi$$

$$\theta = \text{arc tan } y/x \quad (7)$$

The general method of resolution is:

(a) θ is generated in a high-gain loop which uses equation (6) as the control equation.

(b) Diode function generators are used to obtain $(\sin\theta)$ and $(\cos\theta)$.

(c) Electronic multipliers supply the products $(x \sin\theta)$ and $(y \cos\theta)$.

The complete resolver system uses two diode function generators, two electronic multipliers and one high-gain amplifier connected as shown in Figure 2.

If the gain of the amplifier is large and if the circuit is stable, we have

$$A = -K(x\sin\theta - y\cos\theta)$$

and

$$y\cos\theta - x\sin\theta = \frac{-A}{K} \cong 0$$

then

$$\theta = \text{Arc tan } y/x \quad (8)$$

Equation (8) shows that if the system is stable, the output will be the desired value $\theta/1.8$. The 0.005-ufd capacitor placed around the amplifier prevents high-frequency oscillation. Smaller values of capacitance will suffice, but the value chosen here is not objectionable in most applications.

The loop gain of this circuit is

$$G = -Kr \quad (9)$$

and since $r \geqslant 0$, the loop gain will always be non-positive; thus the loop is stable for all input polarities.

The desirable loop gain is negative, large, and *constant* for all values of inputs. If the quantity r can be removed from equation (9) these desired conditions can be met.

Mr. Johnson described three methods of removing r.

Method 1

You can place a divider around the high-gain amplifier in Figure 2 so that the effect is division of the inputs by r.

Method 2

Since

$$r = \leqslant |x| + |y| \leqslant \sqrt{2}\,r \quad (10)$$

the quantity $|x| + |y|$ may be used as a good approximation of r. This quantity can be easily generated and used for automatic gain control as in Method 1.

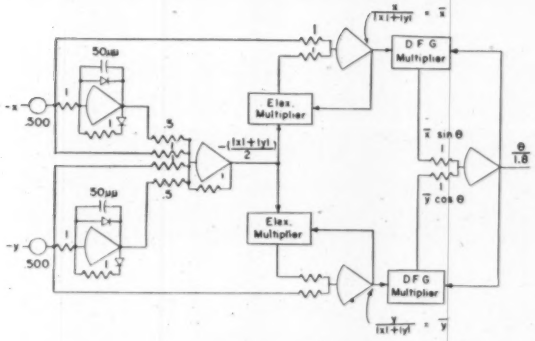

Fig. 3. Resolver using method 3 for automatic gain control.

Method 3

If new inputs are defined so that

$$\bar{x} = \frac{x}{r} \quad \text{and} \quad \bar{y} = \frac{y}{r} \qquad (11)$$

then

$$\bar{r} = \sqrt{\frac{x^2}{r^2} + \frac{y^2}{r^2}} = 1$$

and the loop gain will be

$$G = -K\bar{r} \qquad (12)$$

which shows the loop gain to be constant. As before, $|x| + |y|$ can be used as an approximation of r to keep the gain constant to within less than one order of magnitude.

Figure 3 shows the complete circuit diagram for the resolver using Method 3 for automatic gain control and $|x| + |y|$ as the gain control factor. (In Fig. 3 the diode function generators and multipliers in the resolver circuit are combined and only θ is generated. If r is required, it may be obtained by mechanizing the relationship $r = \sqrt{x^2 + y^2}$ or, if sin θ and cos θ are available from the DFG as shown in Figure 2, using two additional multiplier channels and a summer to mechanize $r = x \cos \theta + y \sin \theta$.—Ed.)

The potentiometers are set to 0.5 to prevent overloading the system, as $|x| + |y|$ may be as much as 200 volts.

Mr. Johnson's presentation elicited the following questions and answers:

Millard Brenner (Electronic Associates, Long Branch, N. J.): "What is the advantage of using this resolver?"

Johnson: "It has two advantages: (1) Some computing facilities do not have resolvers, and may only need one once a year. If they use this resolver their capital investment can be kept down. (2) This resolver has a much higher frequency response."

W. F. Blodgett (Electronic Associates, Long Branch, N. J.): "What type of DFG was used?"

Johnson: "A 22-segment Berkeley generator."

Blodgett: "Are the diodes temperature-controlled?"

Johnson: "No."

Fagan: "What is the accuracy?"

Johnson: "Somewhat better than 1%."

Blodgett: "Where does the 1% error arise?"

Johnson: "Principally from drift in the DFG and multipliers."

Blodgett: "Is there any tendency for the multiplier to smooth out the function?"

Johnson: "Yes."

Workshops

Following the meeting there were one-hour workshop sessions as follows:

ANALOG-DIGITAL CONVERSION, moderated by *Dave Prince;* RESOLVER TECHNIQUES, moderated by *Bob Johnson;* PROCESS CONTROL, moderated by *E. G. Holmes.*

In the afternoon members toured the high-frequency induction laboratory, where an analog computer is used to control rate of heating of aircraft skins. They visited the subcritical reactor assembly and later the Hydro-Dynamic Laboratory, where a model simulating tidewater conditions in the Palm Beach basin area was on display.

WS/C SEPT. MEETING ON "NONLINEAR ALGEBRAIC EQUATIONS"

Bill Kindle (EAI Computation Center, El Segundo, Calif.) was one of two speakers to address the September 1957 meeting of the Western Simulation Council on "The Solution of Non-Linear Algebraic Equations on an Analog Computer." The Sylvania Electronic Defense Laboratory at Mountain View, California was host, and *Dov Abramis* (Convair, Pomona, Calif.) presided.

Questions caused Bill to present his paper somewhat differently, but we give it to you here just as he wrote it.

Kindle on Analog Computer Solutions

"On the analog computer we are accustomed to the process of pulling ourselves up by our boot-straps to the extent of computing higher-order derivatives in a differential equation by first assuming that the lower-order derivatives and the dependent variable are going to be available and then proceeding to integrate to obtain them.

"If this boot-strap philosophy goes to our heads and we glibly extend it to algebraic equations there results a rude awakening in clanging bells, flashing lights, and slamming servos.

"Since implicit linear algebraic equations can always be solved explicitly with only the inconvenience of the ensuing algebra and the resulting combinations of coefficients, our real concern is with implicit nonlinear algebraic equations.

"These problems may arise as part of a system of differential equations, so that we are obliged to solve the algebraic equations in order to solve the associated differential equations, or it may just be that the iteration processes necessary to solve a system of implicit non-linear algebraic equations can be done more rapidly and less expensively on the analog than on a digital computer. In this latter case it is usually possible to mechanize the computer to drive to the solution and hold the solution tight enough so that parameters of the system of equations can be varied with time and produce plots of the dependent variables of the problem versus various parameters. Thus, the analog computer can generate continuous graphs of the solution of implicit algebraic equations and can rapidly turn out great quantities of data in a convenient graphical form.

"The alternative prospect of digital solution requires the iteration of recursion formulas, yields point solutions instead of continuous solutions, and comes out in tabular rather than graphical form unless digital plotting equipment is available. Although the digital computer could be coded to use information from a previous

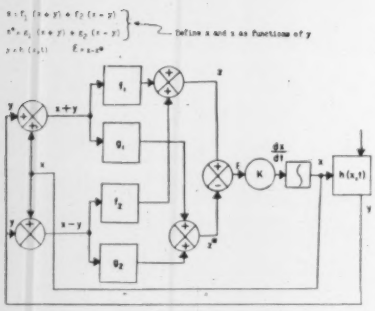

Fig. 4. Computer nulls error signal.

computation to obtain a first guess for each successive iteration, the problem of getting onto the solution in the first place is an imposing one. On the analog computer, the solution can be sought manually by adjusting integrator initial conditions with the computer in Reset and can then be turned into Operate to hold onto the solution after it has been located.

"When implicit non-linear algebra shows up in systems of differential equations it is necessary that the settling times of circuits constructed to solve the algebraic equations be short enough that they do not introduce excessive lags, and thus yield spurious dynamic effects.

"There are at least a couple of different approaches to the problem of constructing circuits to solve implicit non-linear algebraic equations.

"One is the technique of simply connecting up circuits which satisfy the equations to be generated and then attacking the computer with a handful of capacitors and a fond hope of being able to stabilize the circuits.

"An alternate method is to write non-linear differential equations which have a steady-state solution equal to the solution of the algebraic equations and hope to be able to make the gain high enough to yield short settling times over the entire range of variation of the dependent variables appearing in the equations.

"In any event, a system of implicit non-linear algebraic equations should be approached in a well-organized fashion. Since there is always a choice of methods to solve such equations, some investigation should be made to determine which method is most likely to behave well.

"One approach is to generate the most important terms in the forward loop and to feed back the less important terms.

"Also, it is a good idea to get a clear picture in mind of cause-and-effect in the physical system being simulated, as a guide to deciding which equation to solve for which variable.

"Another consideration is that it is easier to stabilize the circuits if the static feedback loops (i.e., closed loops through amplifiers and not broken by integrators) can all be broken at a single point and the stabilization networks introduced at such a point.

"One way of implementing the technique of setting up a differential equation which satisfies the non-linear algebraic equations in the steady state is to solve two different algebraic equations for the same dependent variable and define the difference as an error signal; this error signal is amplified, integrated, and fed back as a "solved for" variable. The computer then nulls the error signal to solve for the implicit variable. Figure 4 shows this implementation diagrammatically.

"By taking the partial derivative of the error signal with respect to the "solved for" variable, the correct sign relationship between the error signal and the output variable can be determined for negative feedback, and the magnitude of the gain and its variation with dependent variables can be computed. The gain variation gives the variation of the time constant of the nulling circuit."

Discussion

Norm Irvine (Convair, Pomona, Calif.) wanted to know why the method outlined by Korn & Korn and others for the solution of algebraic equations wouldn't work to stabilize non-linear simultaneous differential equations like those described by Bill Kindle. In this method, each equation is written in a form equal to zero, and zero is replaced by the input of an integrator. Bill said that his system was practically the same idea, but he thought the method he outlined was easier to use and required less luck. Bill added that it was possible to stabilize systems of non-linear equations with a handful of capacitors and a lot of luck.

Irwin Pfeffer (Ramo-Wooldridge Corp., Los Angeles, Calif.) asked what would happen if the sine of the error term changed during the solution of the problem. This would convert the system from a degenerative one to a regenerative one: "That would be sad!" said Bill.

Dov asked, "Isn't Bill's method practically the same as the idea of putting a capacitor around a high-gain summing amplifier in a typical dividing circuit?" Bill replied that it was, and that the dividing circuit is essentially solving a non-linear algebraic problem.

Fig. 5. High-speed digital plotter plots beautiful curves.

Chuck Walli (American Aerophysics) said, "I tried Bill's method first. It didn't work! So I tried the 'handful of capacitors plus luck' method. It did work."

Chuck followed Bill's talk with a description of a "beautifully non-linear" hydraulic valve problem. We have written him for amplification of his notes and hope we can give you the story of his talk next month.

Information (Without Theory)

Those who saw *Bill Bradley's* Scientific-Atlanta high-speed digital plotter demonstrated agree that it is capable of plotting beautiful curves (see Fig. 5). Some specs on the plotter are as follows:

Graph size— 7½" x 10" and 10" x 15"
Accuracy— 0.1% of full scale
Slewing speed— 50" per second
Plotting rate—Up to 6 points per sec

Indexing type print wheel provides 1 to 6 different symbols.

Specs on the curves are classy-fied, but we know you'll see the point!

* * *

Saw our friend *Vic Corey* (Donner Scientific Co., Berkeley, Calif.) at WESCON and found as usual that he had some interesting gadgets to show. Largest was their new console analog computer which can be purchased with as few as 10 chopper-stabilized amplifiers and later built up to 30 as "needs and pocketbook dictate."

Smallest was a 1.38" x 1.13" x 1.39" hermetically sealed servo accelerometer weighing only 3.2 ounces,

12 degrees of freedom in dynamic loading

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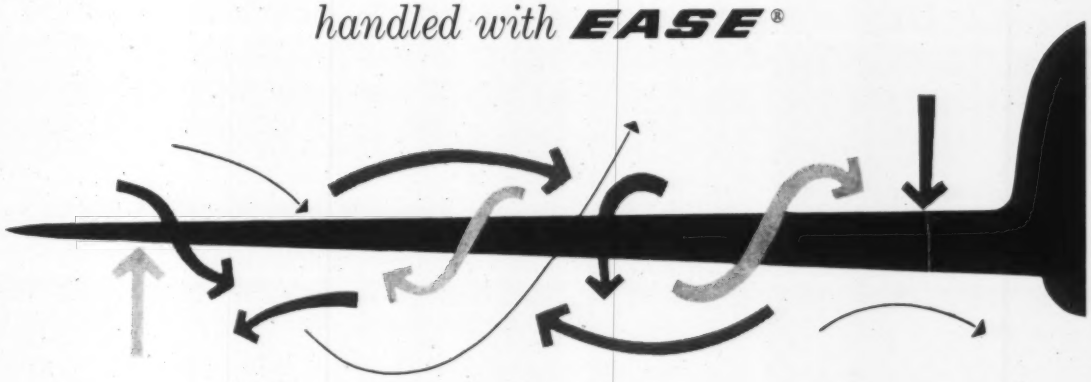


Boeing Engineers choose the new Beckman/EASE Model 1133

To analyze landing, gust and blast loads in calculations involving 12 degrees of freedom, the Seattle Division of Boeing Airplane Company needed an analog computer of exceptional capacity and versatility. It had to meet exacting current requirements . . . handle the largest problems with which the Engineering Department Structural Dynamics Unit had yet worked . . . and be capable of expansion for the requirements of future studies.

Boeing engineers found the match to their comprehensive performance specs in the EASE Model 1133, specially adapted to this application. With the competent help of the local Beckman/Berkeley engineering representatives, Hawthorne Electronics of Seattle and Portland, the Dynamics Staff translated its requirements into a computer system fully capable of handling the immediate projects . . . and of being expanded to twice its initial size.

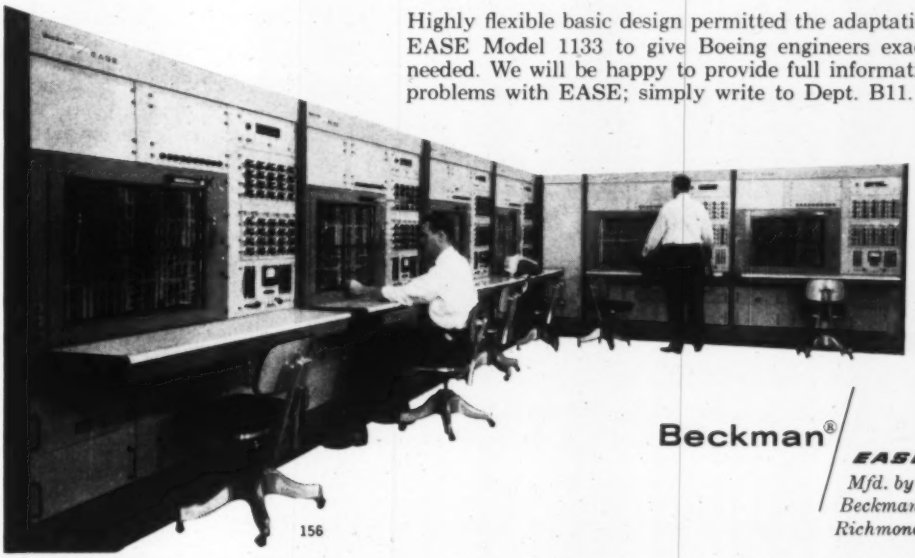
The new EASE facility consists of six control consoles which can be operated independently or as a single large-scale computer. Each console has a fully-shielded, short-proof 3600-hole patchboard, and controls an unusually large amount of computing equipment. New high-power Beckman/EASE Model 1049B amplifiers supply 40-milliamp output, important in solving large, complex matrices. The system is complete with output scanners that print-out 1000 problem voltages as part of the built-in problem checking function.

Highly flexible basic design permitted the adaptation of the new Beckman/EASE Model 1133 to give Boeing engineers exactly the equipment they needed. We will be happy to provide full information on how to solve *your* problems with EASE; simply write to Dept. B11.

Standard 1133 Console Capacity

One Standard Model 1133 Control Console can be used to operate all of this equipment:

- 104 amplifiers
- 210 coefficient potentiometers
- 20 Function Generators
- 24 Electronic Multiplier channels
- 12 Servo multipliers and resolvers
- Recorders, relay amplifiers, limiters, and transport delays and other auxiliary equipment
- 144 external trunks



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which is offered in ranges from ±005 g to ±50 g, with an accuracy of 0.1% full scale.

In between in both size and price was an all-electronic two-channel "Information Delay Generator"*, actually two special-purpose analog computers pre-programmed to solve the Laplace delay e^{-sT}. Delays from 0.5 to 10.0 seconds can be obtained with accuracies from 0 for low frequencies to 5% for frequency components equal to 0.75/selected delay.

* * *

Received a couple of letters from across the Atlantic which we found interesting. One from the Ministry of Supply, Guided Weapons Department, Royal Aircraft Establishment, Farnborough, Hants., England, reads in part: "At the present time I am concerned, among other things, with handling 'free-free' flexible beam problems on analogue computers, and with greater realism in the simulation of hardware. The beam problem has taken us well beyond the subject matter of any papers I have so far read, which deal with the treatment of rather less difficult aspects of the subject. Perhaps I shall have an opportunity to say more about this under the auspices of your Council."

Sincerely,
M. Squires

* * *

Another from Short Brothers & Harland Ltd., Seaplane Works, Queens Island, Belfast, Ireland, says:

"The activities of the Simulation Council are indeed of considerable interest to us and we would particularly welcome any comments your various groups have to make on simulation of aircraft control systems in which actual components are connected in the loop and a pilot is used to close the overall loop through visual stimuli. This problem has been giving us some trouble lately and we feel that some of your members may have experience which would benefit us. Our ideas on the subject are summarized in an article 'Simulation Techniques in Aeronautics' to be published shortly in the Journal of the Royal Aeronautical Society, and this may be of some interest to your members.

Yours faithfully,
James J. Foody,
Head of Analytical
Department"

*Delaying information is no problem around here, Vic. What we need is a gadget to give use a little *advance* info.

Also received a letter from *Tom Connolly* (Princeton Computation Center, Princeton, N. J.) saying in part: "Ro Favreau has suggested that I bring to the attention of your group the course 'Analog Computer Applications' which we offer from time to time, here at the Princeton Computation Center. We first gave the course in May of this year and repeated it in September. Our only firmly scheduled date for the future is for the two-week period starting November 11. Almost certainly we will have sessions in 1958, but no dates have been chosen."

"The course is intended for practicing engineers, scientists or technologists with experience amounting to at least a Bachelor's degree from an approved educational institution, together with two years' technical experience after graduation. The experience should preferably have been gained in the design, development or research fields. The course should also be very suitable for computer engineers, or operators with the above general qualifications and a very limited or narrow experience of analog computers."

"The course will be given at the Princeton Computation Center of Electronic Associates, Inc."

"The tuition fees will be $300.00."

"The number attending a course is restricted to a maximum of 20."

* * *

On the digital side Dick Canning and Roger Sisson* offered a course in New York City October 28 to November 1. Tuition was $250, and the course covered the "important high-cost installation period for EDP**—after the planning has been done and the equipment has been ordered, and ending when the system gets into day-by-day operation."

He Went Thataway!

Arthur Cotts (erstwhile Secretary of the Central Simulation Council) to Applied Physics Laboratory, Johns Hopkins University, Silver Springs, Maryland.

Hideo Mori (our present Secretary of Eastern SC) to Hydel, Inc., 99 First Street, Cambridge 41, Mass.

*Canning; Sisson and Associates, 1140 S. Robertson Blvd., Los Angeles 35, Calif.

**Electronic Data Processing System.

Thot-and Food for Same

Some time ago Edmund Berkeley wrote in *Computers and Automation*:

"So far, the best form of comunication at any computer meeting seems to be the cocktail party; no one sits down; everyone is mobile; you can wander around, say many hellos, introduce many people, and be introduced to many.

"But there ought to be much better techniques of communication at computer meetings: (1) The tag which you wear at a meeting should show: your name; your organization; *your main interests*. This would give a wonderful starting point. (2) In your pocket you should have a thumbnail sketch of yourself, a Who's Who report,—so that while you read your new acquaintances, he can read yours.

"If computer people suffer from lack of communication, we have mainly ourselves to blame: we are supposed to be experts in information handling, information engineers!"

Computer Events

Simulation Councils, Inc. (annual meeting)

Dates: 9-13 December 1957

Place: Washington, D. C. (Sheraton Park Hotel)
This meeting will be held in conjunction with the Eastern Joint Computer Conference. The EJCC session on Real-Time Simulation should be of considerable interest to Simulation Council Technical Sessions for which papers have been solicited. For information on the meeting write Dr. R. M. Howe, Department of Aeronautical Engineering, University of Michigan, Ann Arbor, Mich.

Midwestern Simulation Council

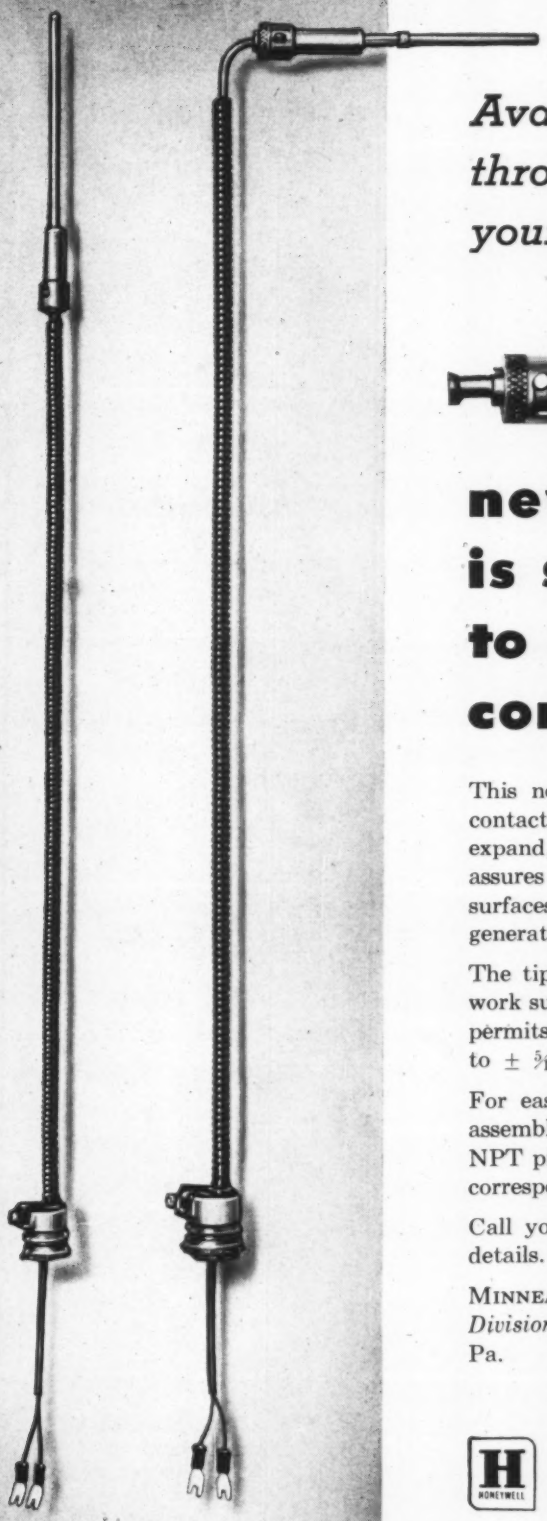
Next meeting of the MSC will be held in conjunction with the annual meeting of Simulation Councils, Inc., listed above.

February meeting of the MSC has been tentatively planned for Wright Air Development Center with Milt Warshawsky as host.

Central Simulation Council

Date: 3 February 1958

Place: Monsanto Chemical Company, St. Louis, Missouri
For information write Theodore J. Williams at Monsanto.



Available in either straight or 90° angle construction for ease of installation.

Available through your...

HSM
HONEYWELL SUPPLIES MAN

new thermocouple is spring loaded to maintain continuous contact

This new Honeywell thermocouple keeps in continuous contact with the work surface, even though the surface may expand, contract or become displaced during operation. It assures accurate temperature measurement of internal surfaces such as those of plastic extrusion machines or generator bearings.

The tip of the thermocouple is held securely against the work surface by an *Inconel-X* spring. Moreover, the spring permits insertion of the thermocouple in holes varying up to ± 5/16" from the specified depth.

For easy inspection and replacement, the thermocouple assembly is provided with a bayonet adapter to fit a 1/8" NPT pipe connection. The assembly itself is fitted with a corresponding cap to engage this adapter.

Call your nearby Honeywell Supplies Man for complete details. He's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

How would

. . . to centralize all your process data . . .

to have all types of data read out in digits on one compact piece of equipment?

. . . to have new data processing flexibility which defies obsolescence . . .

to be able to change logging sequence at will . . . easily switch types or ranges of inputs . . . add inputs quickly . . . to move smoothly from one process to another?

. . . to gain greater accuracy . . .

to process data with an accuracy that's barely approached by present data processing equipment?

you like...

...to **have a really dependable system...**

with all components designed for remarkably long life and utmost operating efficiency . . . with maintenance needs pared to the minimum?

...to **simplify data processing...**

to eliminate the complexities you associate with gathering and correlating data . . . to have a data processing system that's easy to operate and maintain?

Honeywell's New Digital Readout System gives you all of these advantages

See it demonstrated at the Exposition for the Chemical Industries

Visit us and get full details!

MINNEAPOLIS-HONEYWELL REGULATOR CO.,
Industrial Division, Wayne and Windrim Avenues,
Philadelphia 44, Pa.

Honeywell

First in Controls

INSTRUMENTS and AUTOMATION

New Instruments

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Capacitors	2140	Electronic Instruments	2132	Process Control	2099
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FOR FURTHER INFORMATION USE THE POSTAGE FREE ORDER CARD ON PAGE 2171

COMPUTING and DATA PROCESSING

DIGITAL COMPUTER

New 610 Auto-Point Computer desk-side electronic computer can handle problems ranging from in-

surance premium computation to jet aircraft design. Illustration shows operator designing a power transformer in less than twenty minutes. (An engineer using a slide rule and a desk calculator would require 6 hr.) Data are fed into 610 on reels of punched paper tape in unit directly behind operator, who is entering variable data into machine system through control keyboard at right. —*Int'l Business Machine Corp., 590 Madison Ave., New York 22, N. Y.*

For more information circle **201** on inquiry card.

whether additional loads, additional lines, and/or additional generating stations are feasible—and if so, their optimum locations.—*General Electric Co., Computer Dept., Phoenix, Arizona.*

For more information circle **202** on inquiry card.

AC NETWORK ANALYZER

New Miniaturized AC Network Analyzer puts on a desk-top the power lines and generating stations of an electric utility power transmission system by simple jack-plug selection; operates on 115 v, plugs into office outlet, consumes 300 w. It enables management and engineers to determine

ANALOG COMPUTER

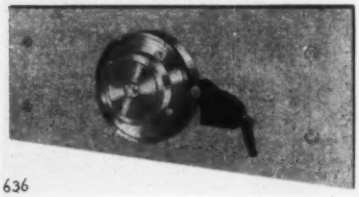
New table-top special-purpose analog computer, designed primarily to solve office and factory business pro-

duction problems, can be operated by average clerical worker after eight hours' instruction because it is simple to operate: dials are set according to data and appropriate signal buttons are pushed. Illustration shows operator calibrating computer's matrix. —*Computer Dep't, General Electric Co., 1103 N. Central Ave., Phoenix, Ariz.*

For more information circle **203** on inquiry card.

MAGNETIC STORAGE DRUM

New Monrobot permits every project engineer, for less than the price of a good 'scope, to have his own drum for testing, R&D, etc. Unit comprises motor, drive, mounting



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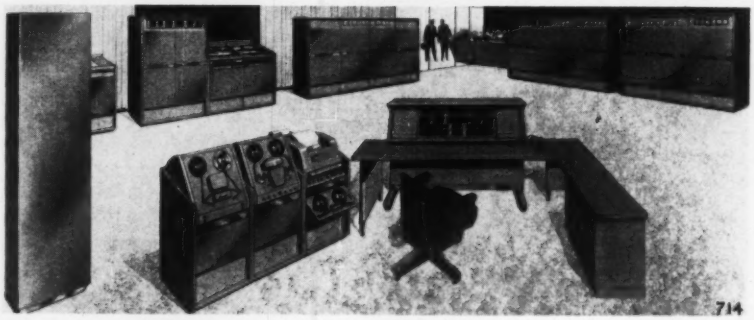
GENERAL-PURPOSE ELECTRONIC DATA PROCESSING SYSTEM



New Datatron 220 is said to "incorporate the capabilities of million-dollar-plus computers at about half the cost." Basic arithmetic speeds are over 300,000 additions or subtractions, 30,000 multiplications and 15,000 divisions per minute. Up to 600 million characters of information can be filed and available in seconds for automatic computing.—*Electro-Data Div., Burroughs Corp., 460 Sierra Madre Villa, Pasadena, Calif.*

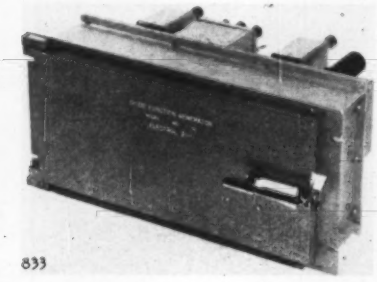
For more information circle **204** on inquiry card.

base, bearings, and a hub to which selected rims are attached; comes mounted on a sturdy aluminum plate ready for 19"-rack installation. Drum diameter, speed, read/record heads and associated circuitry are selected by systems designer to meet his individual requirements.—*Monroe Calculating Machine Co., Electronics Div., Morris Plains, N. J.*

For more information circle **205** on inquiry card.

FUNCTION GENERATOR

New Model 100 diode function generator, for use in analog computers and other systems requiring genera-



833

tion of nonlinear functions, provides accuracy and operating features previously unavailable in instruments of this type. It will generate function represented on punched card to an accuracy of 0.1%. It will retain this function for an indefinite period to an accuracy of 0.02%.—*Electrol, Inc., 9000 W. Pico Blvd., Los Angeles 35, Calif.*

For more information circle **206** on inquiry card.

AUTOMATIC TAPE PUNCHING AND PROGRAMMING MACHINE

New ComptoTape punch not only converts calculator results into punched paper tape but has a pro-

568

gram board which automatically punches constant data, such as code numbers, into the tape, freeing the operator to do calculating. It uses 5, 6, 7, and 8-channel paper tape; is actuated by a Customatic Comptometer on which the operator performs calculations. However, instead of writing her answer on paper, operator presses a key. This reads out answer into tape. Up to 102 program steps can be used for each read-out sequence.—*Comptometer Corp., 1735 N. Paulina St., Chicago 22, Ill.*

For more information circle **207** on inquiry card.

ELECTRICAL MEASURING INSTRUMENTS

Welch D. C. PANEL METERS

SENSITIVE 20 MICROAMPERES MOVEMENT

• Accuracy 2% of full scale deflection

MODEL NO. 350

Welch Model 350 Panel Meters are often used in temporary "bread-board" assemblies and in "homemade" devices so common in electronics laboratories. In such work it is frequently more convenient to have an attached rather than a separate meter.

Suitable for such applications as measuring grid currents and currents from photoelectric tubes and cells. They have alnico magnets, sapphire bearings, and especially selected pivots to make possible the extremely sensitive 20 microampere movement.

MODEL NO. 351

These precision instruments are expertly designed, highly sensitive, sturdily built and adapted for work requiring the most rugged performance.

- **Stable and Well-Damped**
- **Flush Mounting Bakelite Cases**
- **High Torque Ratio**

MODELS

350—3½ inch round—2.4 inch scale
351—3 inch square—2.4 inch scale
451—4½ inch rectangular—3.5 inch scale

MODEL NO. 451

MICROAMMETERS
MILLIAMMETERS
VOLTMETERS

Microammeters 0-20 up to 0-500
Milliammeters 0-1 up to 0-500
Ammeters 0-1 up to 0-30
Voltmeters, various ranges, 100 to 50,000 ohms per volt
Zero Center Ammeters
DB Meters
Rectifier Instruments
Thermocouple Meters
Special Scaled Meters

A complete line of round, square, and rectangular meters is manufactured by Welch.

WRITE FOR OUR METER CATALOG

W. M. WELCH SCIENTIFIC COMPANY

DIVISION OF W. M. WELCH MANUFACTURING COMPANY

ESTABLISHED 1880

1515 Sedgwick St., Dept. C-1, Chicago 10, Ill., U.S.A.

For more information circle **52** on inquiry card.

Telemeter
ANY VARIABLE from Remote Points

Accurate, Fast Acting, Frequency Type Telemeter for Transmission over Wire Lines, Microwave, and Power Line Carrier

Accurate HIGH-SPEED Continuous Telemeter for VOLTS AMPS WATTS VARS ETC.

•

Built-in Self-Calibrating Circuit

•

The Model 1025 Telemeter Transmitter converts DC mv from thermal converters, etc., to 10-30 cps which frequency modulates a built-in audio tone channel. AC 10 to 30 cps or relay outputs are also available. Receiver detects and demodulates transmitted signal, generating a DC mv for operation of recorders or indicating instruments. Up to 45 telemeters can be multiplexed.

Any communication link, including power line carrier, microwave or wire line may be used.

Over-all accuracy is 1% with a response speed of 1 second. Equipment features a built-in calibration circuit for 10% and 90% receiver check, and 10 cps and 30 cps transmitter check.

Any quantity which may be converted into a DC millivoltage or will operate a slidewire may be telemetered.

WE CAN HELP YOU
Our Applications Department is ready to assist you in your control, telemetering or communications problem. Phone DEerfield 4-3100.

Write for Technical and Application Data.

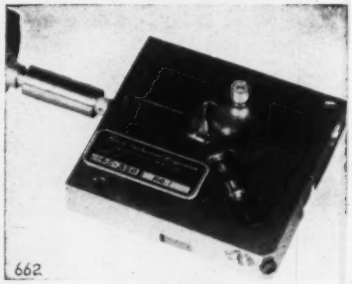
Radio Frequency
LABORATORIES, INC.
Boonton, New Jersey, U. S. A.

For more information circle **53** on inquiry card.

NEW INSTRUMENTS

SQUARING MECHANISM

New bidirectional mechanical device for squaring and extracting square roots, said to be "the smallest of its



type yet produced," is for use in all types of mechanical analog computers. With aluminum case it weighs 10 oz; with steel 20 oz.—*Belock Instrument Corp., College Point, N. Y.*

For more information circle **208** on inquiry card.

TAPE FILING DEVICE

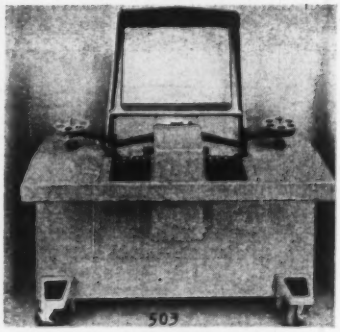
New VISIsleeve, said to be a revolutionary visible system for rapidly filing and finding long punched pa-

per tapes, places up to 2,880 long tapes at a single operator's fingertips. VISIsleeves are rigid transparent plastic containers which are arranged side by side in a 24" or 30" wide VISIsleeve panel. Each accommodates one tape of any channel width and up to 75 ft. long.—*VISIrecord, Inc., Copiague, Long Island, N. Y.*

For more information circle **209** on inquiry card.

FILM VIEWER

New Model RG-550 projects film-recorded data onto a rear projection screen for evaluation of data which



can be motion pictures or oscillograph records. A system of interchangeable film transports provides flow-film and rapid rewind functions in addition to accurate frame-to-frame registration of perforated film from 8 mm to 70 mm. Automatic frame rate timer provides 1, 2, 3, 4 and 6-sec frame-advance intervals.—*Richardson Camera Co., 171 W. Magnolia Blvd., Burbank, Calif.*

For more information circle **210** on inquiry card.

STATIC CARD READER

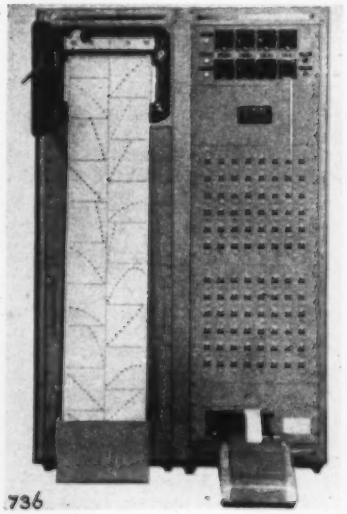
New static punched card reader for use with industrial processing and control systems accepts any standard

punched card having as many as 80 vertical columns with 12 punching positions in each column. As card is put into reading slot, rollers automatically place it in reading position; signal light indicates unit is "sensing"; and switch automatically activates associated control or production equipment. When card is no longer needed it is ejected. Cards inserted upside down are ejected immediately. —*Electronics Division, Peerless Electric Co., Warren, Ohio.*

For more information circle **211** on inquiry card.

GRAPHIC PLOTTER WITH DIGITAL READOUT

New Model 114 Autographic Plotter can have a digital converter driven in tandem to operate a tape punch,



HERE'S WHAT YOU'VE WAITED FOR—THE NEW

CEC RAPID-ACCESS DATARITE MAGAZINE

- Rapid access means a developed, dry oscillogram in less than *one second* at rates up to 25 inches per second.
- Direct attachment to any 5-119 Recording Oscillograph provides up to 50 standard galvanometer recording channels on the record.
- Standard silver-halide paper yields optimum contrast and resolution, records that may be duplicated by any conventional process.
- The DATARITE–5-119 combination is the only rapid-access data recorder that works equally well with either conventional or flash timing.

Attractively priced, the DATARITE Magazine converts your 5-119 Recording Oscillograph to a 50-channel direct writer! No modification of the oscillograph is necessary. Record capacity is 400 feet of 12-inch thin-base paper. Writing speeds of over 30,000 inches per second are standard with conventional silver-halide papers.

For the complete story of the revolutionary 5-036 DATARITE Magazine, inquire at your nearby CEC field office, or write for Bulletin CEC 1598-X4.

CEC's 5-119 RECORDING OSCILLOGRAPH–preferred throughout the world for dynamic-testing reliability–is available in both 36 and 50-trace a-c and d-c models. Write for Bulletin CEC 1536-X16.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

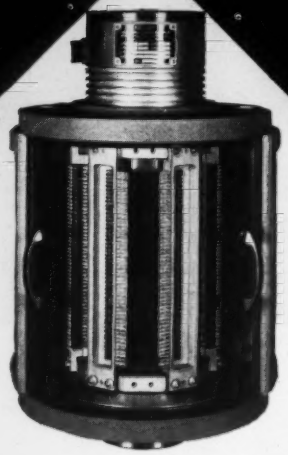
OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

For more information circle **54** on inquiry card.

The New

BRYANT MAGNETIC STORAGE DRUM

Economical . . . Precise . . . and Versatile!



The new 512A Bryant general purpose magnetic storage drum is built to meet the exacting requirements of all permanent storage problems, yet is versatile enough to be used as a laboratory instrument. It is the result of 25 years' experience in designing and producing high-speed precision spindles. These standard 5" dia. x 12" long drums are stocked for immediate shipment at a price that reflects quantity manufacture, far below the cost of customer-designed drums.

Features:

- Guaranteed accuracy of drum run-out, .00010" T. I. R. or less.
- Integral motor drive—Bryant precision motor
- Capacities to 625,000 bits
- Speeds up to 12,000 R. P. M.
- 500 kilocycle drum operation possible
- Accommodates up to 240 magnetic read/record heads
- Provides for re-circulating registers as well as general storage
- High density ground magnetic oxide coating
- Super-precision ball bearing suspension
- Vertical mounting for trouble-free operation

Write for complete details on the new No. 512A

BRYANT GAGE and SPINDLE DIVISION
P. O. Box 620-I, Springfield, Vermont, U. S. A.
DIVISION OF BRYANT CHUCKING GRINDER CO.

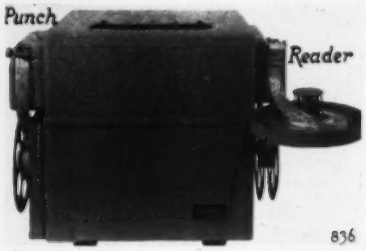
For more information circle **55** on inquiry card.

card punch, electric typewriter, or printer. Usable with strain-gage, thermocouple, or millivolt inputs, it receives and plots each channel on an individual graph; is available in 24-, 48-, or 96-channel models.—*Gilmore Industries, Inc., Dept.* 2001, 5713 *Euclid Ave., Cleveland* 3, *Ohio.*

For more information circle **212** on inquiry card.

LONG-RANGE CODED-DATA TRANSMITTER-RECEIVER

New Teledata is the first machine for sending, receiving and checking data encoded in more than five chan-



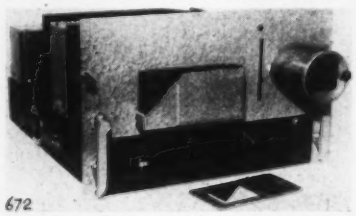
836

nels of punched paper tape over existing wire services; does away with former limitations in wire transmitting information used in integrated data processing systems. It can transmit and receive 5-, 6-, 7-, and 8-channel tape. Reader is in operation when sending or transmitting information; punch operates when receiving information. Thus tape is simultaneously reperforated and checked on punch of remote Teledata. Tapes are then used to actuate other equipment to produce automatically invoices, production orders, tabulating cards, etc. —*Friden Calculating Machine Co., Inc., San Leandro, Calif.*

For more information circle **213** on inquiry card.

CURVE-TO-VOLTAGE CONVERTER

New Program Scanner is a novel non-mechanical instrument that converts a curve drawn on graph paper



672

into a voltage to be used to program heat, test load, computer, etc. It operates when a photographic transparency of a curve is inserted in front of its "flying spot" tube which is swept by a vertical line moved horizontally across tube's face. Output is available as a variable-width pulse or dc (ac output obtained by adding a converter). Accessories include an automatic camera to facilitate mak-

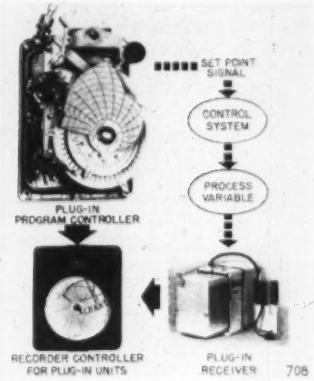
ing transparencies, and time base generators to drive horizontal sweep. —*Spar Engineering & Development, Inc., Paxson & South Aves., Wyncote, Penna.*

For more information circle **214** on inquiry card.

PROCESS CONTROL

PROGRAM CONTROLLER

New "plug-in" program controller simplifies process automation by the receiving, recording, and program-

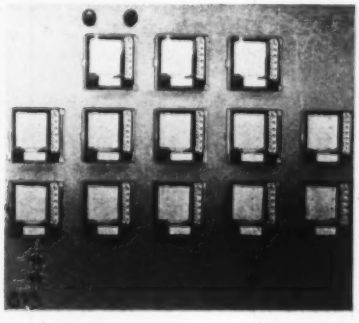


ming of process variables within a single recorder case. Inexpensive 6" aluminum cam is chart-printed and easily field-cut to desired shape. During programming cycle, one or two precision snap-action switches can be operated at specified points as often as desired. In addition to unlimited variety of programming, controller can be set to: (1) repeat full cycle continuously; (2) stop automatically at end of each cycle; or (3) omit or repeat any portion of cycle.—*Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.*

For more information circle **215** on inquiry card.

MINIATURE INDICATORS AND RECORDERS

New line of matching miniature recording and indicating instruments for every type of variable includes instruments for pneumatic transmission, electronic transmission, and electrical telemetering, as well as self-balancing potentiometers and bridges and pressure gages. Typical



ABSOLUTE PRESSURE INDICATOR
... For Precise Vacuum Work

Accuracy:	1/300 of full scale
Sensitivity:	1/500 in *all* ranges
Ranges:	0-50mm Hg. 0-100mm Hg.
	0-200mm Hg. 0-410mm Hg.
	0-800mm Hg. 390-800mm Hg.
Dial Sizes:	2¾" or 6" diameter for all ranges

Write for Publication No. TP-28-A

WALLACE & TIERNAN INCORPORATED
25 MAIN STREET, BELLEVILLE 9, NEW JERSEY
In Canada, Wallace & Tiernan, Ltd. — Toronto
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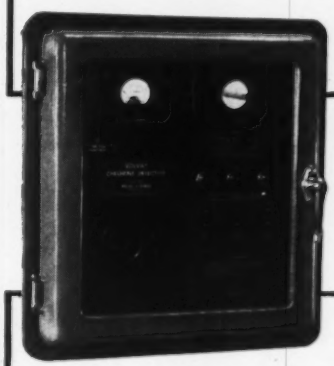


HOW TO DETECT 3 PARTS CHLORINE IN A MILLION PARTS AIR

New W&T Solvay Chlorine Detector*
detects as little as 3 p.p.m. chlorine in a continuous air-stream sample. Automatically sets off alarm at higher concentrations.
Write for Publication 50.118

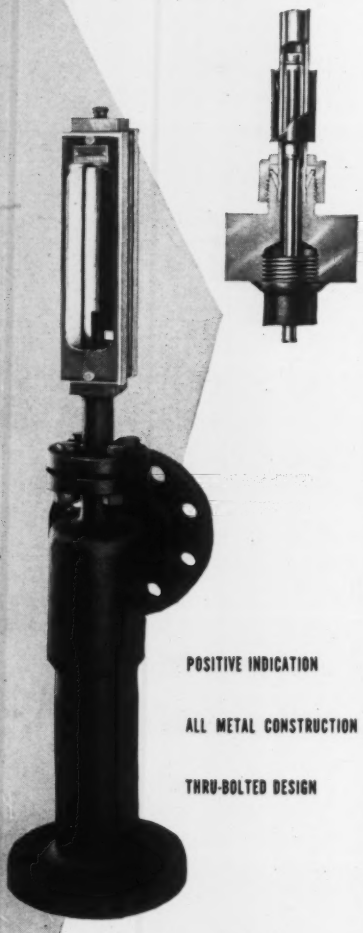
WALLACE & TIERNAN
INCORPORATED
25 MAIN ST., BELLEVILLE 9, N. J.
I-55 *Manufactured under patent license from Solvay Process Div., Allied Chemical & Dye Corp.

For more information circle **56** on inquiry card.

BROOKS LEADERSHIP
achieved by design

AR-MET ROTAMETER

. . . takes practically *all* fluids off the hard-to-handle list



POSITIVE INDICATION

ALL METAL CONSTRUCTION

THRU-BOLTED DESIGN

Working with highly penetrable fluids . . . high temperatures, high pressures? Then, Brooks Ar-Met Rotameters are made to order for you.

The Brooks Ar-Met Rotameter with Mag/Na/Vue indicating extension is shown . . . however, Ar-Met meters are also available with six other alarm and transmission extensions, both electrical and pneumatic. WRITE FOR BULLETIN 130

BROOKS ROTAMETER COMPANY
1157F STREET, LANSDALE, PENNSYLVANIA

A complete line . . .
BROOKS ROTAMETERS
. . . for every service
TM

For more information circle **57** on inquiry card.

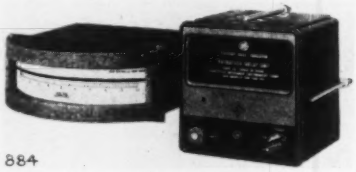
NEW INSTRUMENTS

electronic or telemetered measurements can be presented on a graphic panel or console with the more usual pneumatic instrument type measurements, and not segregated to another locating. All instrument groups also feature interchangeability of recording and indicating types with plug-in-chassis. Color coding is consistent throughout new line.—*The Bristol Company, Waterbury 20, Conn.*

For more information circle **216** on inquiry card.

CONTACT-TYPE INDICATOR CONTROLLER

New Contact-Making Control System consists of a Reference Standard edgewise panel indicating instrument



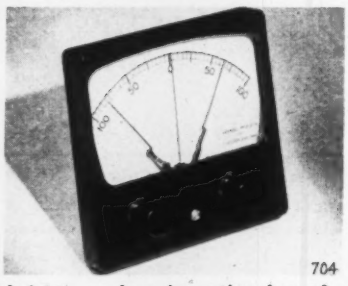
884

and a thyratron-relay control unit. All instruments conform to A.S.A. specs for 0.25% and 0.5% portable secondary standards and are modified by addition of either upper or lower contacts or both.—*Sensitive Research Instrument Corp., 310 Main St., New Rochelle, N. Y.*

For more information circle **217** on inquiry card.

CONTACT-TYPE INDICATOR CONTROLLERS

New Contact Meter-Relays, designed for use in Wheatstone bridge circuits, can operate on signal changes



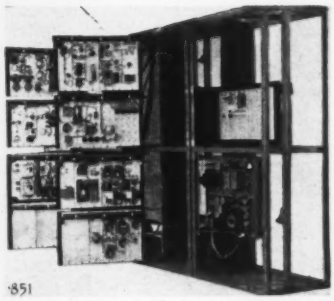
704

of 0.1% or less in active leg of a bridge. Dials read 100-0-100, with numbers expressing percentages of scale. Full-scale sensitivities begin with 0-5 microamperes or 0-5 mv and range up to 0-50 amp and 0 to 500 v.—*Assembly Products, Inc., Chesterland, Ohio.*

For more information circle **218** on inquiry card.

MEASUREMENT & CONTROL EQUIPMENT

New Series E functional mounting arrangement for AccuRay measurement and control equipment comprises single panels as basic unit with each function of control system mounted



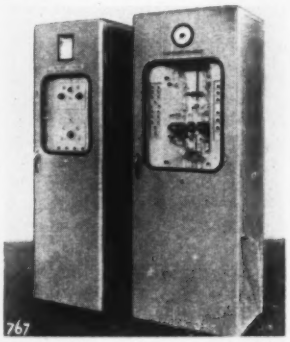
851

independently on panel. Functions or panels in turn are grouped on door frames. Swinging frames provide easy access; all maintenance checking can be done from front of cubicle by one man.—*Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus 12, Ohio.*

For more information circle **219** on inquiry card.

AUTOMATIZED TITRATOR

New Titromatic Analyzer not only performs the work of 2 or 3 skilled chemists in continuous analysis of a



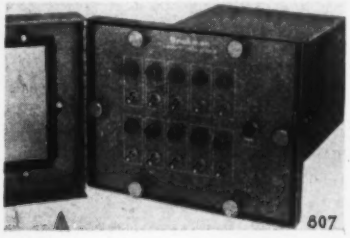
767

chemical process during manufacture but yields a continuous record. Main components: (1) Chemical Unit which contains an array of glass vessels controlled by automatically-operated taps; (2) Electronic Control Unit which determines precise sequence of operations.—*Instrument Div., Robertshaw-Fulton Controls, 2920 N. Fourth St., Philadelphia 33, Pa.*

For more information circle **220** on inquiry card.

AUTOMATIC STREAM SELECTOR

New Automatic Stream Selector is for use with maker's Model 120 and Model 220 Industrial Gas Chromatographs as well as hydrometers, infrared, and other stream analyzers. Numbered lamps indicate by the in-



807

BREEZE BELLOWS WIN

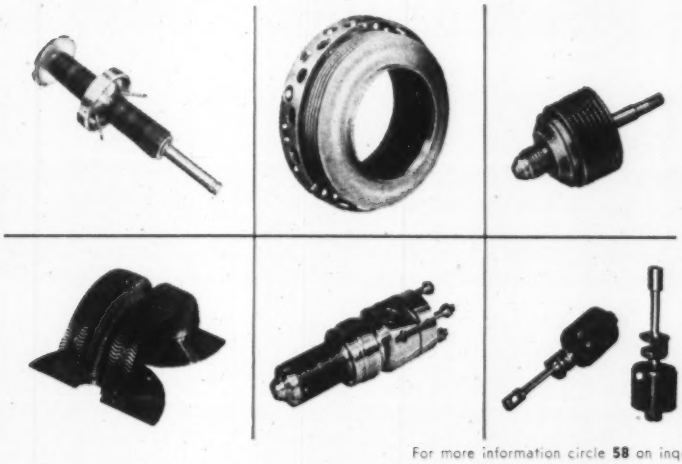
the tough game of high performance

Breeze bellows engineers work in that challenging area where ready-made designs won't do the job. Every project is a custom project, engineered specifically for each problem application.

We have a wealth of experience with all weldable alloys such as Inconel X, titanium, Ni-Span, Hastelloys, Stainless 300 and 400 steels.

We are solving critical problems in instrumentation, fuel regulation, pressure switches and expansion joints, hot air ducting, pressure surge tanks, packless valves, expansion and vibration joints, oscillating and rotating shaft seals, atomic and nuclear reactors.

Breeze invites your inquiries on bellows jobs *beyond the routine* . . . for the most exacting requirements.



BREEZE

CORPORATIONS, INC.

700 Liberty Avenue, Union, N. J.

BREEZE MARK

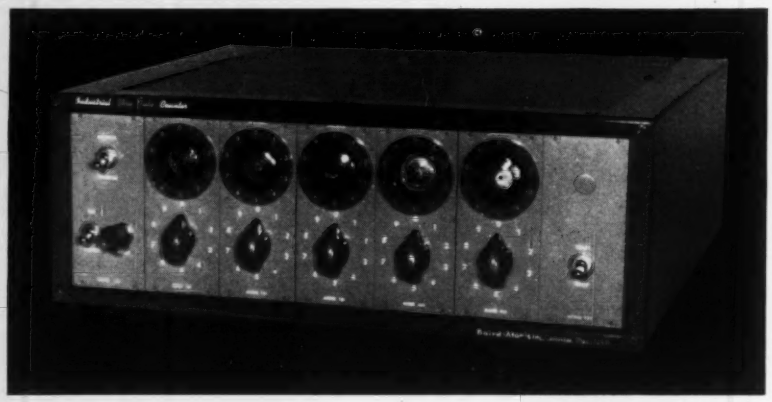
For more information circle **58** on inquiry card.

INSTRUMENTATION FOR BETTER ANALYSIS

SUPER-FAST, HIGH PRECISION

INDUSTRIAL COUNTING and CONTROL

WITH BAIRD-ATOMIC
ELECTRONIC COUNTING INSTRUMENTS



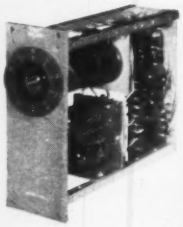
Many standard and special models available for counting, sorting, machine cycle, unit flow, packaging and other industrial and control applications.

Electronic speed and accuracy with up to 20,000 unit counts per second. DEKATRON* cold-cathode glow transfer tubes give constant visual reference to total count.

DEKATRON* TUBES AVAILABLE SEPARATELY

The DEKATRON cold-cathode glow transfer counting tube used in B-A instruments requires far less power than "hot" tubes. DEKATRON tubes permit simplified circuitry with fewer components than ordinary tubes resulting in greatly increased reliability. The moving glow spot within the tube indicates total and eliminates the need for additional indicating lights. Baird-Atomic is the sole distributor of DEKATRON tubes in the United States and Canada.

COMPLETE PLUG-IN STRIPS FOR CUSTOMER ASSEMBLY



Unitized plug-in strips with DEKATRON tube, numbered bezel and drive circuitry are available in many functional types. These B-A plug-in strips save assembly time and permit the customer to more easily incorporate the counter into existing panels or equipment.

For additional information on industrial counting instruments, DEKATRON tubes and plug-in strips write to:

*Patented.

Baird-Atomic, Inc.
33 UNIVERSITY RD., CAMBRIDGE 38, MASS.

Baird Atomic

For more information circle **59** on inquiry card.

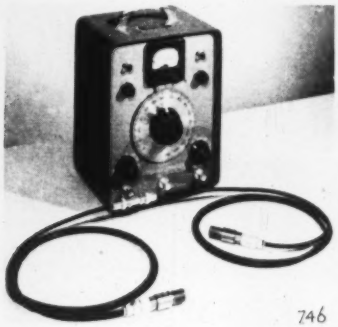
tensity of their color what streams are included (in chromatographic system), what streams are being monitored, and the particular system being analyzed. New selector can be set for automatic or manual operation.—*Beckman Instruments, Inc., Process Instruments Div., 2500 Fullerton Rd., Fullerton, Calif.*

For more information circle **221** on inquiry card.

PRESSURE and VACUUM

TRANSIENT DIFFERENTIAL PRESSURE INDICATOR

New Model DPI-114 SLM Differential Pressure Indicator measures both fast and slow transient differen-



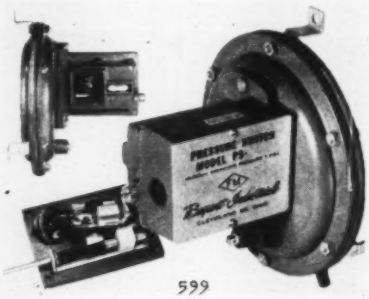
746

tial pressures at any two points in a pneumatic or hydraulic system, as well as on an aerodynamic model; is said to be "the only commercially available fast-response crystal type transducer that can be calibrated by conventional static methods." Hookup is simple: two SLM pickups of opposite polarity; makes possible measurement of a 0.1 psid change at a 3000 psig level.—*Kistler Instrument Corp., 15 Webster St., No. Tonawanda, N. Y.*

For more information circle **222** on inquiry card.

PRESSURE SWITCH

New Model PS pneumatic pressure switch closes a 1200-watt circuit under preselected pressure, suction, or differential; is Factory-Mutual Lab approved. New design features a high-stability Buna N/Nylon diaphragm. Three interchangeable color-



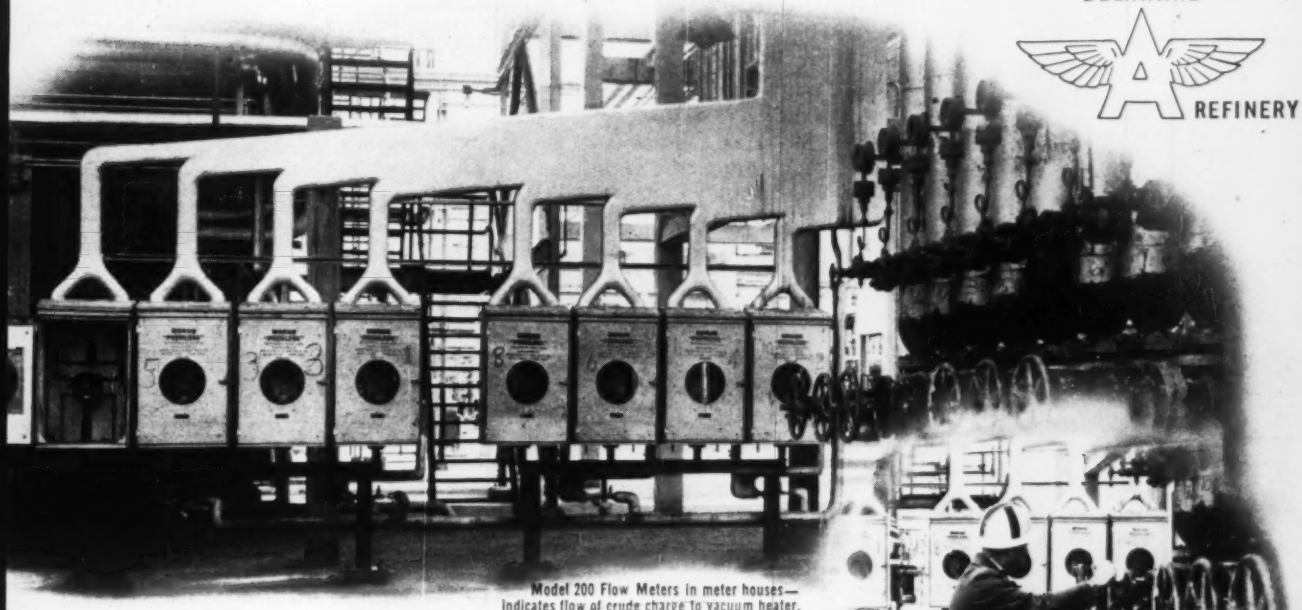
599

Circle **60** on inquiry card. ⟶

BARTONS working for TIDEWATER'S

DELAWARE

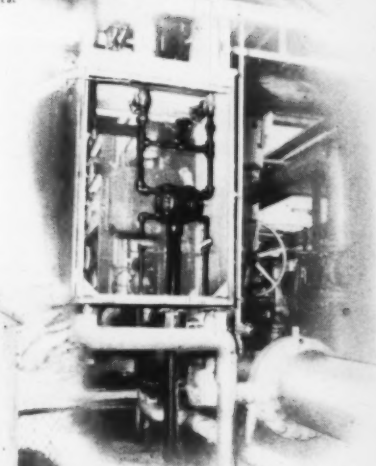
REFINERY



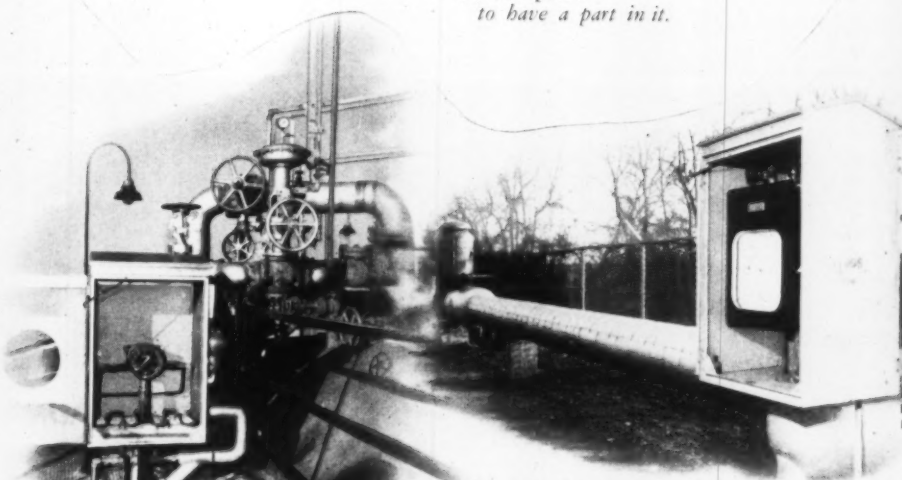
Model 200 Flow Meters in meter houses—
indicates flow of crude charge to vacuum heater.

BARTON is pleased to have been selected
by Tidewater Oil Co., and C. F. Braun & Co.,
to work with them on the instrumentation of this modern Refinery.
Because of their constant zero and stable calibration
under varying temperatures and elevated pressures,
BARTON Differential Pressure Units were chosen
for use on all flows for accounting service.
In addition, units are being used on flow measurement
both for local visual operation and for transmission
to the Control Room to dictate to the central information,
logging and control systems which put into practice
the newest techniques
in process instrumentation.
We are proud
to have a part in it.

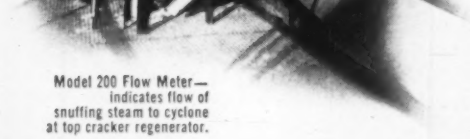
Altering flow of crude charge
while observing change
on the indicators.



Model 199 Differential Pressure Unit
on Taylor Transmitter—
measures, indicates and transmits flow,
of stripping steam to
cracker fractionating tower.



Model 202 Flow Meter—
records water flow from
remote well station.

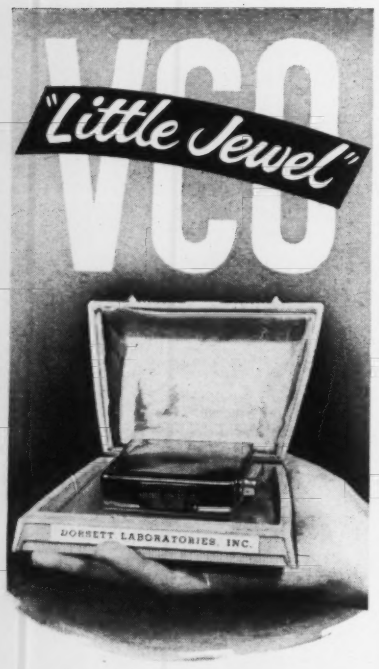


Model 200 Flow Meter—
indicates flow of
snuffing steam to cyclone
at top cracker regenerator.

For better measurement, try BARTON — a complete line of rupture-proof bellows-type meter bodies, indicators, recorders, switches, transmitters, controllers and integrators for precise measurement of flow, liquid level and differential pressure.

BARTON INSTRUMENT CORPORATION

580 MONTEREY PASS ROAD, MONTEREY PARK, CALIFORNIA

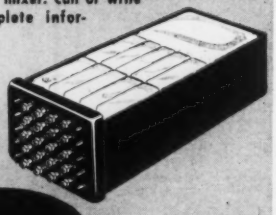


Half the Size... Uses 1/100 the Power

OF THE SMALLEST CONVENTIONAL VCO NOW AVAILABLE

Uses subminiature tubes and printed circuitry. 9 telemetering oscillators, operational mixer and self-contained power supply, all packaged within .09 cubic feet. Available on all standard RDB channels . . . with either 7.5% or 15% deviation. Uses Cannon DA-15P plug. Any 9 basic oscillators may be used on 9 different RDB channels. Inputs and outputs individually adjustable. Standard 0-3 v input sensitivity.

Linearity: ±0.5% of band width. Power: 30 milliwatts per oscillator. Stability: Drift less than ±3% of full band width. Vibration: 30 G acceleration up to 500 cps. Shock: Up to 100 G. Input: .5 megohm. Output: Sine wave, 1% distortion. Designed to operate as package unit with mixer. Call or write for complete information.



DORSETT *Laboratories, Inc.*

Tel. JE 4-3750

Box 862 • • Norman, Okla.

For more information circle **61** on inquiry card.

NEW INSTRUMENTS

coded springs provide three pressure ranges: 0.1-0.5", 1-10", and 4-30" water, and screwdriver adjustment sets desired trip pressure anywhere within range of installed spring. Surges up to 3 psi are accommodated.—*Bryant Industrial Products Corp., 17700 Miles Ave., Cleveland 28, Ohio.*

For more information circle **223** on inquiry card.

DIFFERENTIAL PRESSURE TRANSMITTER

625

New Model P3D utilizes magnetic reluctance ratio principle, measures differential pressures at line pressures up to 5000 psi, is available in full-scale ranges from 0.1 to 500 psid with 1% static and dynamic measurement accuracy. Pressure sensing diaphragm is magnetically coupled to two coils embedded in body, whence extreme mechanical rigidity and ability to measure high-frequency components. Full-scale volumetric displacement is only 0.0004 cu in.—*Pace Engineering Co., 6914 Beck Ave., North Hollywood, Calif.*

For more information circle **224** on inquiry card.

GAS PRESSURE REGULATOR

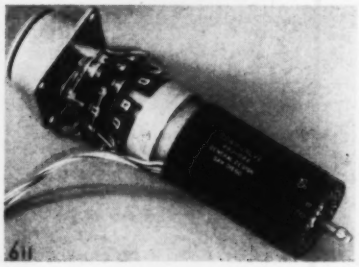
544

New RV-30 appliance gas regulator for mainburner and pilot loads is said to be "the smallest regulator of comparable capacity"; is of tamper-proof construction (hermetic type); cannot be field disassembled; maintains accurate regulation at extremely low flow rates of tiny pilot flames even with dirt or other impurities in gas line.—*Maxitrol Co., Detroit 39, Mich.*

For more information circle **225** on inquiry card.

PRESSURE SCANNER

New miniaturized (5¼" long) solenoid-driven Model 48D Scanivalve samples 48 different pressures sequentially; allows pressure and force data to be taken simultaneously; requires only one transducer calibration. Used with *x-y* plotters, it gives direct $\Delta p/q$ pressure profiles. Available speeds from one complete scan (48 pressures) per second to 1 scan per minute.—*General Design, 631-30th St., San Diego 2, Calif.*


611

For more information circle **226** on inquiry card.

SPECIAL-PURPOSE SOUND PRESSURE & BLAST PICKUPS

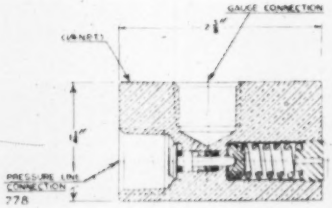
New M-141A, B, C, D, and E modifications of M-141 type high-level microphones meet specific requirements of Ballantine 310A; General Radio 1551A and 759B, Dawes Limited 1400D, and Scott 410B; can be used directly with a general-purpose VTVM or sound level meter without a preamplifier or power supply to make exact sound pressure measurements from a few microbars to several million microbars over entire AF range.—*Massa Laboratories, Inc., 5 Fottler Road, Hingham, Mass.*

754

For more information circle **227** on inquiry card.

GAGE PROTECTOR

New adjustable gage protector cuts off flow to gage whenever system pressure exceeds spring setting; reopens when pressure drops below cut-out point; also acts as a snubber of damaging pressure fluctuations. Any desired closing from 50 to 300 psi, or from 500 to 5000 psi, easily made by user.—*Superior Hydraulics Div., Superior Pipe Specialties Co., 15201 St. Clair Ave., Cleveland 10, Ohio.*

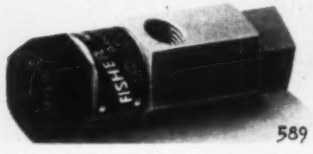


778

For more information circle **228** on inquiry card.

GAGE PROTECTOR

New Gauge Saver with Built-in Snubber, for hydraulic, fuel and pneumatic systems, provides a positive and automatic protection against gage overload and damage from excess vibration. Compression spring controls shut-off point and can be ad-



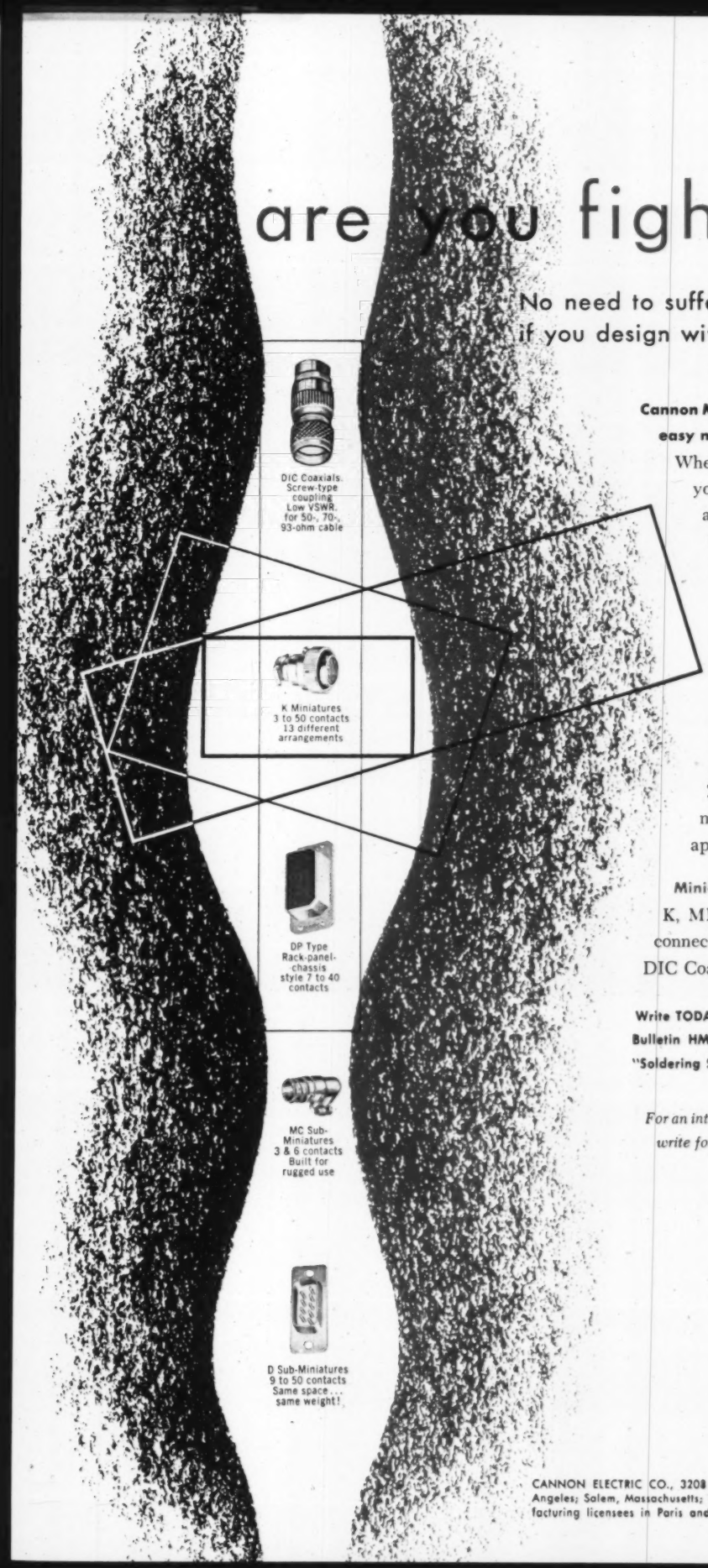
589

Circle **62** on inquiry card. ⟶

H. J. Bürchel

are you fighting SPACE?

No need to suffer from engineering claustrophobia, if you design with CANNON PLUGS in mind!


DIC Coaxials. Screw-type coupling. Low VSWR. for 50-, 70-, 93-ohm cable
K Miniatures 3 to 50 contacts 13 different arrangements
DP Type Rack-panel-chassis style 7 to 40 contacts
MC Sub-Miniatures 3 & 6 contacts Built for rugged use
D Sub-Miniatures 9 to 50 contacts Same space... same weight!

Cannon Miniature and Sub-Miniature Plugs are rugged, easy mating, unusually versatile, neat and compact. When you design with Cannon Miniatures in mind you'll get complete electrical circuit dependability in a very small space. Up to 50 contacts in ½ or ⅓ the area taken by standard multi-contact connectors!

Rectangular and circular types. Hermetically sealed, vibration and moisture resistant, and general purpose designs. Contacts for 5, 10, 15, 25 amps... and miniature coaxial connectors. Practically all five ampere contacts are gold plated. High dielectric insulation in phenolics, resilient materials, glass seals, Zytel, Diallyl Phthalate and Melamine. Aluminum alloy or steel shells, depending upon application.

Miniature lines include: DPA, DPX, DPM, DPG, K, MM, MR and Diamond MB and SM Coaxial connectors. **Sub-miniatures:** D, MC, and Diamond DIC Coaxial connectors.

Write TODAY for new 32-page 2-color Miniatures Bulletin HMC-2. Also, write for Bulletin SM-1, "Soldering Small Contacts."

For an interesting discussion of the broad subject of "Reliability," write for Cannon Bulletin R-1.

CANNON PLUGS

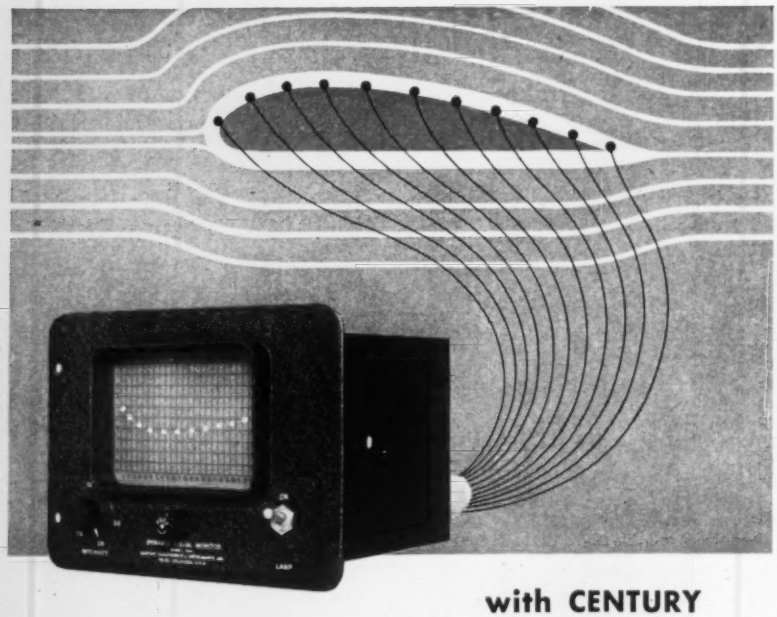
WHERE RELIABILITY IS THE 5™ DIMENSION

AWARENESS OF PROBLEM · INTEGRITY OF INTENT · DESIGN EFFORT · MANUFACTURING CONTROL

Please refer to Dept. 419

CANNON ELECTRIC CO., 3208 Humboldt Street, Los Angeles 31, California. Factories in Los Angeles; Salem, Massachusetts; Toronto, Canada; Melbourne, Australia; London, England. Manufacturing licensees in Paris and Tokyo. Representatives and distributors in all principal cities.

SEE and MEASURE pressure distribution



with CENTURY Model 20 VISUAL MONITOR

Visual presentation of airfoil pressure distribution is achieved by a major airframe manufacturer by means of the Century Model 20 Dynamic Visual Monitor.

By dynamic bargraph display, simultaneous observation of 24 pressure-transduced signals is permitted throughout an extended range of frequencies. Variations in pressure gradient, peak pressures, as well as oscillations associated with sonic flow phenomena are thus presented in continuous analog form.

Information presented by the Monitor permits a high degree of selection of those data for permanent recording by conventional tape or recording oscillograph process. With such discretion available, the great savings in data reduction time becomes apparent.

The Monitor provides a display of the focused light beam from as many as 24 pencil-type galvanometers on a calibrated viewing screen, 2.5″ high x 4.0″ wide. Galvanometers, flat in range of 0 to 42 cps with sufficient deflection sensitivity for direct coupling to most transducers are available. Other galvanometers are available for use in the region of 0 to 240 cps.

Monitoring of temperatures throughout a system or along a given piece of material, monitoring of vibration, flow, colorimetry and current are also vital applications of the Monitor.

Century Electronics & Instruments, Inc.

1333 No. Utica, Tulsa, Oklahoma

For more information circle **63** on inquiry card.

justed to accommodate minor changes. Units are available from stock in 16 different combinations of inlet and outlet connection in all shut-off pressures from 20 to 5000 psi. Operating temperature −65°F to 160°F; maximum operating pressure 10,000 psi.—*Fisher Controls Inc., 1222 Seventh St., Santa Monica, Calif.*

For more information circle **229** on inquiry card.

LOW-PRESSURE SWITCH

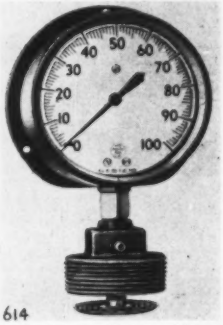
619

New ultrasensitive but economically-priced low-pressure switch can be mounted in any position and is not affected by vibrations. Since there is no flow through sensing element, connecting tubing can be as small as ⅛″ ID. Suitable for pressure, vacuum or differential. Normal range 0.1 to 5.0″ water; others avaliable. Make and break contacts are adjustable; pressure difference required to actuate contacts can be set as low as 0.1″ water.—*Bacharach Industrial Instrument Co., 200 N. Braddock Ave., Pittsburgh 8, Pa.*

For more information circle **230** on inquiry card.

CHEMICAL PRESSURE GAGE

New No. 2594 Capsule Chemical Gage has no gaskets or bolted joints; is recommended for services requiring



614

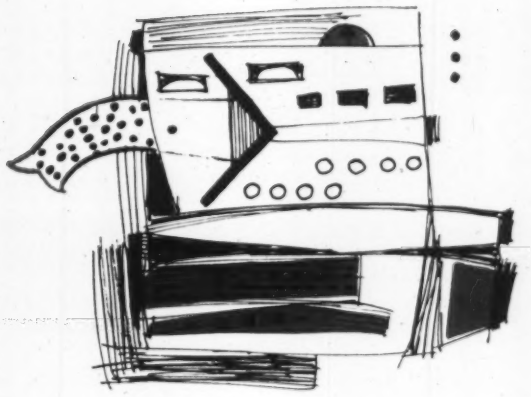
a short pressure-sensing element and for high-temperature service when properly calibrated at operating temperature. Various materials; four dial sizes from 3½″ to 8½″.—*Helicoid Gage Div., American Chain & Cable Co., Inc., Bridgeport 2, Conn.*

For more information circle **231** on inquiry card.

THERMOCOUPLE VACUUM GAGE

New portable battery-operated thermocouple vacuum gage, range 0.5 to 1000 microns Hg, features low tem-

To all readers of INSTRUMENTS AND AUTOMATION:



Several great special issues of INSTRUMENTS AND AUTOMATION are now being prepared for you for 1958:

In January, 1958, Instruments Publishing Company celebrates its 30th birthday with a history-making special issue devoted to **SYSTEMS ENGINEERING.** This issue will answer these questions:

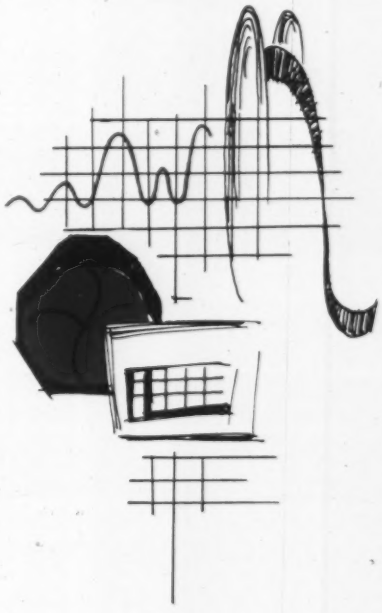
What is systems engineering?????
What is a systems engineer?????
Who specifies systems?????
How does systems engineering affect you—the instrument engineer, the instrument manufacturer, the instrument salesman?????
What have been the experiences of systems engineering firms?????
Systems or sensationalism?????
What is the real role of computers in control?????

You will find many surprises in this special issue, surprises of practical value to all instrument users, to all application engineers, and to all instrument manufacturers.

DON'T MISS THIS 30TH ANNIVERSARY SYSTEMS-ENGINEERING ISSUE—JANUARY, 1958.

Another special issue now being prepared for you is the May, 1958 issue—which will survey the entire field of **recording apparatus and techniques**—chart and tape. Included will be articles covering

Oscillographic recorders
Digital data recorders for dense storage
Automatic null-balancing recorders
Magnetic tape recorders, analog and digital
Photoelectric recorders
Special medical recorders
Multi-segmental recorders
Sweep-balance recorders
Heat-Sensitive recorders
Wax paper recorders
Kymograph recorders



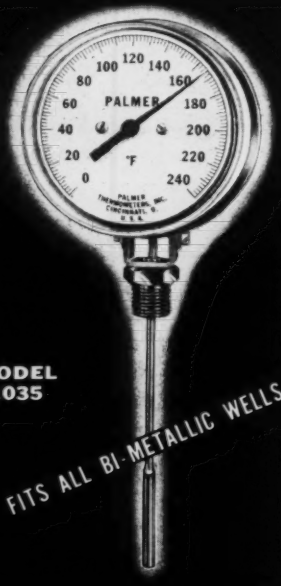
DON'T MISS THE MAY, 1958 SPECIAL RECORDER ISSUE OF INSTRUMENTS AND AUTOMATION, which also will preview the Fourth International Automation Exposition, New York, June 9-13, 1958. Subscription blank is on page 2179, for both your subscription renewal and for your associates who do not now get *I&A*.

INSTRUMENTS
and
AUTOMATION
845 Ridge Ave.,
Pittsburgh 12, Pa.

Outstanding Accuracy

PALMER

Dial Thermometer



Check these functional features

- Direct-drive Bourdon Coil with a filled system for longer lasting accuracy.
- Stem can be placed at any desired angle and case can be rotated to most readable position.
- External calibration for zero setting.
- Unaffected by stem alignment.
- Accurate to one scale division.
- No sticking at any temperature.
- Non-corrosive case.

PALMER

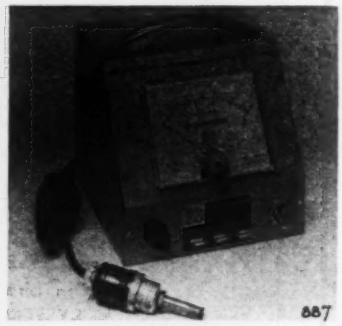
THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

2515 Norwood Ave., Cincinnati 12, O.

For more information circle **64** on inquiry card.

NEW INSTRUMENTS



perature thermocouple that prevents contamination errors.—*Arthur F. Smith Co., 311 Alexander St., Rochester 4, N. Y.*

For more information circle **232** on inquiry card.

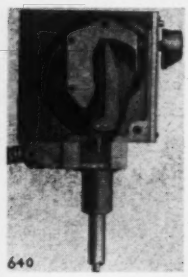
ULTRAHIGH-VACUUM TRAP

New Type TFG-51 Copper-Foil Trap for isolating a vacuum system from contaminating oil vapor and impurities, makes it possible to reach pressures as low as 10^{-13} mm Hg in a glass system by using an ionization gage as a pump; has been found effective for over a month of continuous normal operation before requiring a high-temperature bake-out to clear the foil of adsorbed gases.—*Consolidated Electrodynamics Corp., Rochester Div., 1775 Mt. Read Blvd., Rochester 3, N. Y.*

For more information circle **233** on inquiry card.

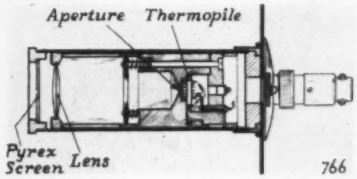
TEMPERATURE

IMMMERSION THERMOSTAT



New thermostat featuring fraction-of-a-degree sensitivity utilizes a thermal element composed of a high-expansion metal tube with a low-expansion steel rod on inside. Differential expansion operates a snap-acting switch rated at 15 amp 125 vac.—*Alloy Bellows, Inc., 18125 Roseland Rd., Cleveland 12, Ohio.*

For more information circle **234** on inquiry card.

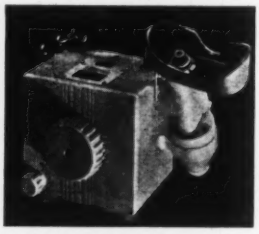


tures rapid response; 2 sec for 98% of full reading (option: special thermopile for 98% in 0.6 sec). Several models available for ranges between 1000 and 3300°F max; all sealed against dust and fumes. Air purge fittings available, also various accessories for steel mills, furnaces, kilns, etc.—*Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa.*

For more information circle **236** on inquiry card.

OPTICAL PYROMETER

New high-temperature range to 4200°C (7600°F) is announced for

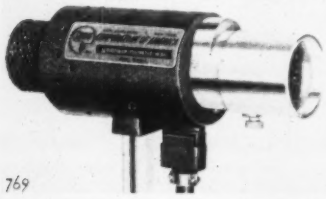


maker's 8626-C Optical Pyrometer. —*Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.*

For more information circle **235** on inquiry card.

INFRARED RADIATION PYROMETERS

New Servotherm Infrared Radiation Heat Detectors are said to combine optics and electronics into a



practical production line instrument; cover range from 50°C to 1300°C; are claimed to indicate temperature variations under 0.05 C°; feature ¼-sec response time. Principle is null-balance: incoming radiation is focused on one cell by Servofrax lens; radiation from internal reference source on the other.—*Servo Corp. of America, New Hyde Park, N. Y.*

For more information circle **237** on inquiry card.

RADIATION PYROMETER

New Land radiation pyrometer utilizes a thermopile consisting of a bank of ten thermocouples connected in series, and a variety of lenses; fea-

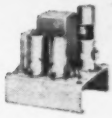
FREQUENCY STANDARDS

*3⅛" high
400 - 1000 cy.

PRECISION FORK UNIT
TYPE 50

Size 1" dia. x 3¾" H. Wght., 4 oz.*
Frequencies: 240 to 1000 cycles
Accuracies:—
Type 50 (±.02% at —65° to 85°C)
Type R50 (±.002% at 15° to 35°C)
Double triode and 5 pigtail parts required
Input, Tube heater voltage and B voltage
Output, approx. 5V into 200,000 ohms

FREQUENCY STANDARD
TYPE 50L



Size 3¾" x 4½" x 5½" High
Weight, 2 lbs.
Frequencies: 50, 60, 75 or 100 cycles
Accuracies:—
Type 50L (±.02% at —65° to 85°C)
Type R50L (±.002% at 15° to 35°C)
Output, 3V into 200,000 ohms
Input, 150 to 300V, B (6V at .6 amps.)

*3½" high
400 to 500 cy.
optional

PRECISION FORK UNIT
TYPE 2003

Size 1½" dia. x 4½" H. Wght. 8 oz.*
Frequencies: 200 to 4000 cycles
Accuracies:—
Type 2003 (±.02% at —65° to 85°C)
Type R2003 (±.002% at 15° to 35°C)
Type W2003 (±.005% at —65° to 85°C)
Double triode and 5 pigtail parts required
Input and output same as Type 50, above

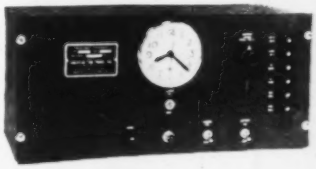
FREQUENCY STANDARD
TYPE 2005

Size, 8" x 8" x 7¼" High
Weight, 14 lbs.
Frequencies: 50 to 400 cycles
(Specify)
Accuracy: ±.001% from 20° to 30°C
Output, 10 Watts at 115 Volts
Input, 115V. (50 to 400 cycles)

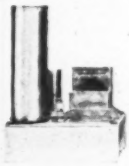
FREQUENCY STANDARD
TYPE 2007T
TRANSISTORIZED

Size 1½" dia. x 4½" H. Wght. 7 ozs.*
Frequencies: 240 to 1000 cycles
Accuracies:—Same as 2003, above
Type 2007S—Silicon type
Input, 28V.
Output, Multitap, 75 to 100,000 ohms
*3½" in 2007S, 400 to 800 cycles.

FREQUENCY STANDARD
TYPE 2121A



Size
8¾" x 19" panel
Weight, 25 lbs.
Output: 115V
60 cycles, 10 Watt
Accuracy:
±.001% from 20° to 30°C
Input, 115V (50 to 400 cycles)



FREQUENCY STANDARD
TYPE 2001-2

Size 3¾" x 4½" x 6" H., Wght. 26 oz.
Frequencies: 200 to 3000 cycles
Accuracy: ±.001% at 20° to 30°C
Output: 5V. at 250,000 ohms
Input: Heater voltage, 6.3 - 12 - 28
B voltage, 100 to 300 V., at 5 to 10 ma.

FREQUENCY STANDARD
TYPE 2111C

Size, with cover
10" x 17" x 9" H.
Panel model
10" x 19" x 8¾" H.
Weight, 25 lbs.
Frequencies: 50 to 1000 cycles
Accuracy: (±.002% at 15° to 35°C)
Output: 115V, 75W. Input: 115V, 50 to 75 cycles.

ACCESSORY UNITS
for TYPE 2001-2

L—For low frequencies
multi-vibrator type, 40-200 cy.
D—For low frequencies
counter type, 40-200 cy.
H—For high freqs, up to 20 KC.
M—Power Amplifier, 2W output.
P—Power supply.

This organization makes frequency standards within a range of 30 to 30,000 cycles. They are used extensively by aviation, industry, government departments, armed forces—where maximum accuracy and durability are required.

WHEN REQUESTING INFORMATION
PLEASE SPECIFY TYPE NUMBER

American Time Products, Inc.

580 FIFTH AVENUE, NEW YORK 36, N. Y.

For more information circle 65 on inquiry card.

Photographer Bernard Hoffman found even the free flow of CO_2 from a cake of dry ice is difficult to control.

Controlling Flow in Fluid Engineering

To tame and control flow accurately, you must relate it to pressure, volume, turbulence and other variables. That's when you can look to the engineering leadership of S. Morgan Smith.

Butterfly valves are a good example. For the majority of processing situations, a wide range of standard R-S Butterfly Valves are assembled from stock for fast shipment. But for special fluid control problems, one or more can be applied to solve your needs. Standard or special, all R-S Butterfly Valves give you uniform flow control through all positions in the normal regulating range. You get minimum turbulence and pressure drop, save on pumping power because of simplified design and streamlined vanes. Compact and light in weight, they give you quick regulation and tight closure.

To learn more about the complete SMS line of Rotovalves, Ball and Butterfly Valves, call on our nearest representative. For information on special engineering, write S. Morgan Smith Co., York, Pa.

S. MORGAN SMITH SMS HYDRODYNAMICS

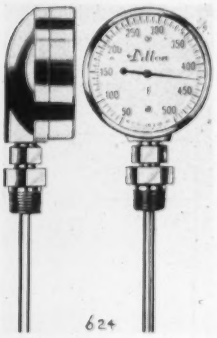
AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED, TORONTO

Rotovalves • Ball Valves • R-S Butterfly Valves • Free-Discharge Valves • Liquid Heaters • Pumps • Hydraulic Turbines & Accessories

For more information circle **66** on inquiry card.

STRAIGHT FORM THERMOMETER

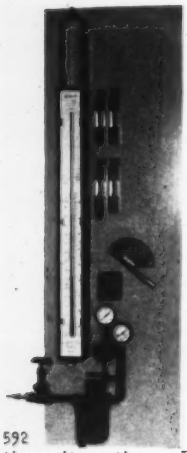
New straight form model added to line of stainless steel thermometers features an adjustable mounting nut which makes it possible to turn and lock the head in position for maximum visibility. Available in 3" and 5" head sizes, in stem lengths from 2½" to 72", in ten ranges from −160-40°F to 200-1000°F.—*W. C. Dillon & Co., Inc.*, 14620 *Keswick St., Van Nuys, Calif.*



For more information circle **238** on inquiry card.

LEVEL

BLOWPROOF TANK GAGE



New Levelux improved type liquid-column gage, suitable for use as a liquid level indicator (photo), as a differential pressure gage or as a flow-rate indicator, is equipped with a blowproof valve so designed and constructed that it is impossible to blow the mercury or other indicating liquid out of the column, even when gage is overanged 10 times its rating.—*Liquidvision Gauge & Control Corp., P. O. Box* 51, *Oceanside, N. Y.*

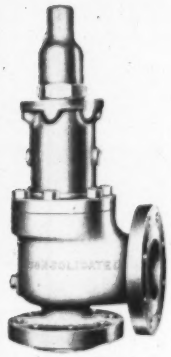
For more information circle **239** on inquiry card.

REMOTE TANK GAGE

New Data-Gage transistorized electronic system measures level of liquid in any of 100 remote storage tanks up

WHAT YOU DON'T SEE

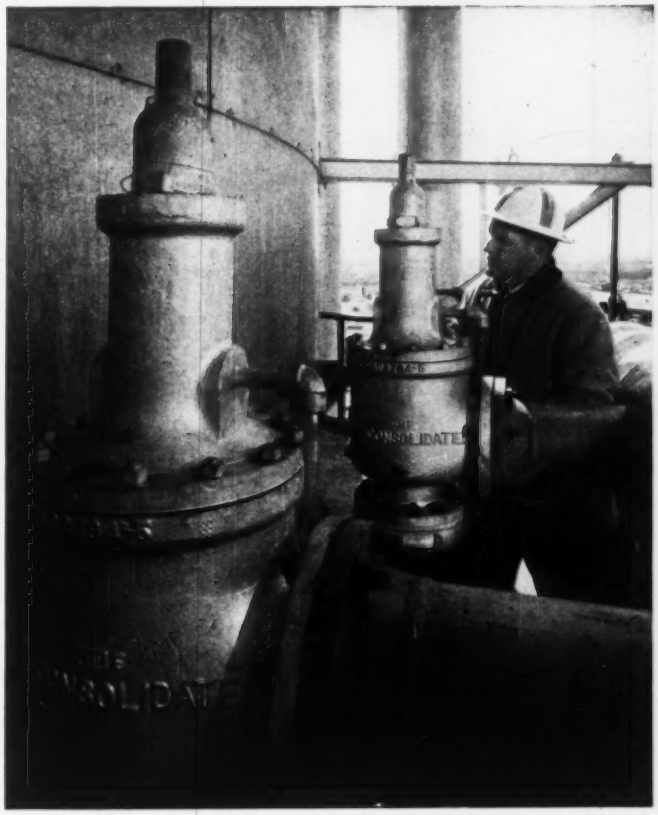
MEANS THE MOST



...in service

...in economy

...in protection



Few Functional Parts. Each part is precision machined and aligned to assure long valve life and minimum maintenance.

Economical "2 in 1" Design. Construction that permits you to convert the Standard valve to the Bellows type *in your own shop.*

Only One Adjusting Ring. Easy to set *before* the valve is installed to obtain peak performance at 4-5% blowdown. Whatever the ring position, *full relieving capacity is certain* because a fixed maximum secondary orifice provides full lift at 10% over-pressure. Even with "superimposed" back pressure in the relieving system, *valve action is consistently positive.*

Temperature-Compensating Disc. Temperature-induced stresses cannot distort the seat. Seating is always tight, even when nominal strains of unanchored discharge piping are present. Minimum guiding area is provided to align the seating surfaces – less chance of a sticking disc holder when corrosion or contamination build up on the guiding surfaces. The seating surfaces are optically-ground flat – servicing is easier, highly economical.

Huddling Chamber and Secondary Orifice Contours take full advantage of the stream pressure and kinetic forces – an exclusive safety feature.

Low-Placed Threaded Section Holds Nozzle in Valve. Assures high resistance to discharge of piping strains. No leakage from strain induced into the nozzle.

Standardized Inlet-Outlet Face-To-Face Dimensions permit easy interchangeability with the valves of some other manufacturers.

Certified and Approved. Both Standard and Bellows Valves – in the full range of sizes and pressures – are approved under ASME Unfired Pressure Vessel Codes and are certified by the National Board of Boiler and Pressure Vessel Inspectors.

Absolute protection for personnel and facilities . . . far fewer inventory and maintenance needs . . . long-term economy. Be assured on every count before you buy another safety relief valve. Investigate fully the quality of Consolidated Safety Relief Valves—then compare. *Write for Catalog 1900.*

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario.*

CONSOLIDATED SAFETY RELIEF VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** TULSA, OKLAHOMA

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Okla.* AIRCRAFT CONTROL PRODUCTS, *Danbury, Conn. and Inglewood, Calif.* "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

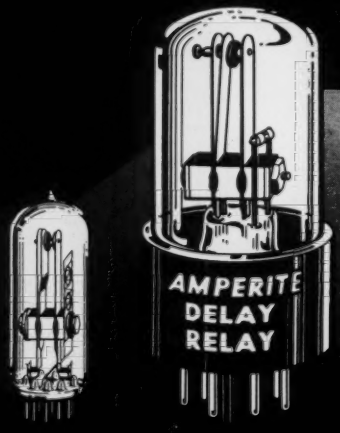
For more information circle **67** on inquiry card.

AMPERITE PREFERRED

by design engineers—because they're

MOST COMPACT • SIMPLEST • MOST ECONOMICAL

HERMETICALLY SEALED



Thermostatic DELAY RELAYS

2 to 180 Seconds

Actuated by a heater, they operate on A.C., D.C., or Pulsating Current.

Hermetically sealed. Not affected by altitude, moisture, or climate changes.

SPST only—normally open or closed.

Compensated for ambient temperature changes from —55 to + 70 C. Heaters consume approximately 2 W. and may be operated continuously. The units are **rugged, explosion-proof, long-lived,** and—**inexpensive!**

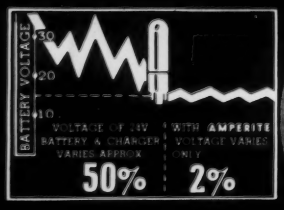
TYPES: Standard Radio Octal, and 9-Pin Miniature . . . **List Price, $4.00.** Standard Delays

Also — **Amperite Differential Relays:** Used for automatic overload, under-voltage or under-current protection.

PROBLEM? Send for Bulletin No. TR-81

BALLAST REGULATORS

Amperite Regulators are designed to keep the current in a circuit **automatically regulated** at a definite value (for example, 0.5 amp.) . . . For currents of 60 ma. to 5 amps. Operate on A.C., D.C., or Pulsating Current.



Hermetically sealed, they are not affected by changes in altitude, ambient temperature (—55 to + 90 C.), or humidity . . . Rugged, light, compact, most inexpensive . . . . . **List Price, $3.00.**

Write for 4-page Technical Bulletin No. AB-51

AMPERITE CO. Inc., 561 Broadway, New York 12, N. Y.

Telephone: CAnal 6-1446

In Canada: Atlas Radio Corp., Ltd., 50 Wingold Ave., Toronto 10

For more information circle **68** on inquiry card.

NEW INSTRUMENTS

to 64 ft with accuracy of $\frac{1}{16}$"; can employ direct wire, 'phone, carrier or microwave transmission. Operator dials tank he wants to monitor and reading appears in lighted numerals on receiver console. System automatically checks itself on tank selection and on accuracy without lapse of time or involvement of separate readings by operator. System can be installed without taking a tank out of operation.—*Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Texas.*

For more information circle **240** on inquiry card.

10,000-psi L-L ELECTRODE

New HP 10 electrode is rated for pressures to 10,000 psi and temperatures to 700°F; has been tested to 15,000 psi; features a new type glass center electrode seal, a captive copper compression gasket, stainless steel shell and 95% aluminum oxide insulator (other materials to order although insulator and center electrode seal should resist all chemicals other than hydrofluoric acid).—*Auburn Spark Plug Co., Inc., 135 York St., Auburn, N. Y.*

For more information circle **241** on inquiry card.

FLOW AND VOLUME

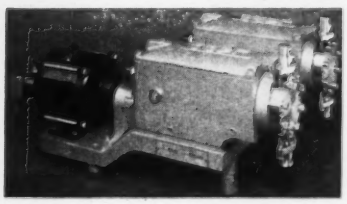
FLOW-RATE TRANSMITTER

New high-frequency Pottermeter turbine-type magnetic-pulse flow-rate transmitter has an output signal up to 3500 cps (up to ten times the standard turbine flowmeter frequency) therefore is of great value in applications involving transient flow studies, digital flow rate indications, and telemetry. Made in sizes from $\frac{1}{8}$" to 12" dia and of any compatible material.—*Potter Aeronautical Corp., Route 22, Union, N. J.*

For more information circle **242** on inquiry card.

DUPLEX MICRO PUMP

New Model LD Microflo Pulsafeeder duplex model pump pumps two liquids in equal volume or each at a different rate but in exact ratio. Pumping rate is adjusted separately



for each side (on a dial calibrated in 1000 increments) while pump is idle or operating. Available in two sizes with both sides rated the same or different. Pressures to 1000 psig with max flow rate 2300 ml/hr and to 2000 psig @ 1040 ml/hr.—*Process Equipment Div., Lapp Insulator Co., Inc., LeRoy, N. Y.*

For more information circle **243** on inquiry card.

CONSTANT-VOLUME CONTROL FOR MIXING UNITS

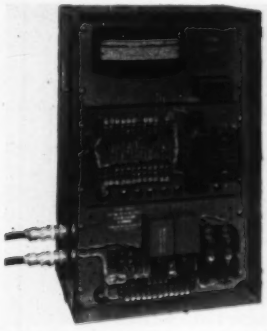
742

New R-316 Air Flow Controller for mixing units used on high-velocity high-pressure double-duct air-conditioning system provides constant-volume air distribution through every unit of system, maintaining a constant flow pattern within each conditioned space, regardless of number of mixing units, length of duct runs or differences in pressure between hot and cold ducts.—*Johnson Service Co., Milwaukee 1, Wis.*

For more information circle **244** on inquiry card.

FLOW COMPUTER

New Type DRF is a complete system from primary element to printed record, which automatically measures,



774

computes, indicates, transmits, and records gas flow through an orifice. All necessary corrections are introduced automatically.—*Southwestern Industrial Electronics Co., 2831 Post Oak Rd., Houston 19, Texas.*

For more information circle **245** on inquiry card.

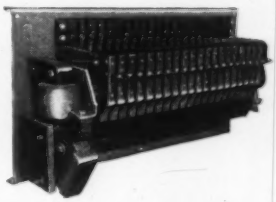
WEIGHT, LOAD

CLASSIFYING SCALE

New Electronic Package Classifier for checkweighing prefilled packages of material "on the run" for underweight, overweight, or both, assures that all units accepted are within specified tolerance requirements. An over-under zero indicator provides a visual check, and tolerance range is

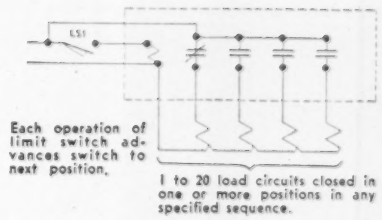
NEW EAGLE STEP SWITCH SIMPLIFIES CIRCUIT SEQUENCING

. . . for machine tools, presses, conveyors, processes

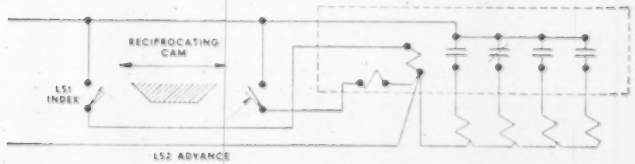


These 3 basic ideas are yours for simplified interlocking or sequencing of multiple load circuits. Any and all three will eliminate many other electrical components, and cut your initial cost.

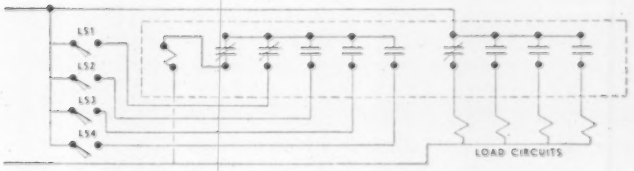
Operating load circuits in sequence: A limit switch on a machine or indexing device closes and opens upon each operation to advance the Eagle step switch. Or a timer may be used to operate each load circuit for a predetermined time.


LS1
Each operation of limit switch advances switch to next position.
1 to 20 load circuits closed in one or more positions in any specified sequence.

Interlock sequence: *Two limit switches* are operated alternately. This provides a safety feature. It insures that the movement of the machine has been completed before the Eagle step switch advances.



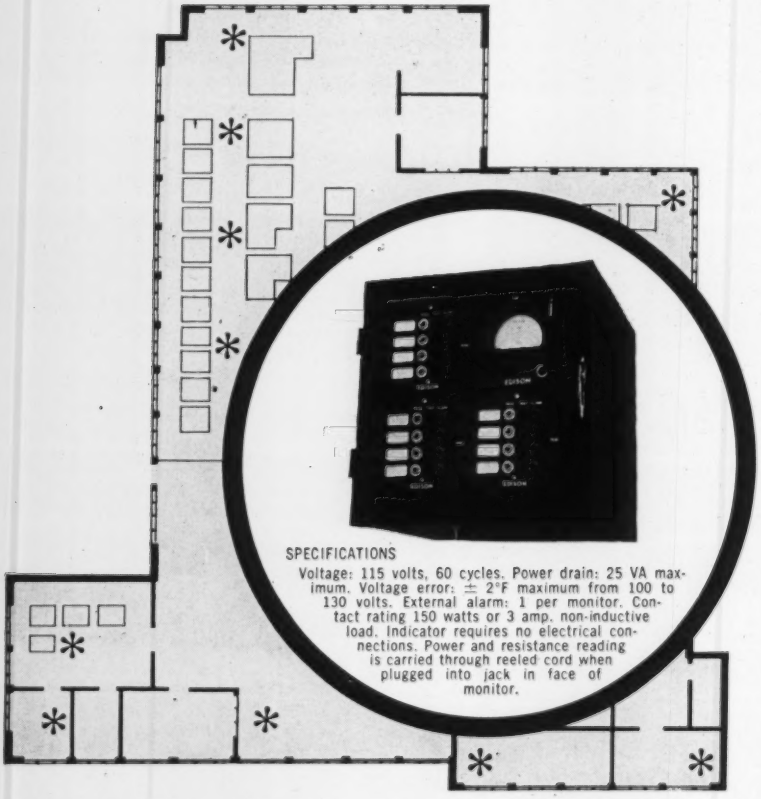
Interlock sequence with several limit switches: Each limit switch advances the Eagle step switch one position. Switches must operate in sequence or the step switch won't advance.



Send for new Eagle Bulletin 850. Simply write to Eagle Signal Corporation, Industrial Timers Division, Moline, Illinois, Dept. IA-1157.

For more information circle **69** on inquiry card.

EDISON'S OMNIGUARD MONITORS CRITICAL TEMPERATURES IN YOUR PLANT



SPECIFICATIONS
Voltage: 115 volts, 60 cycles. Power drain: 25 VA maximum. Voltage error: ± 2°F maximum from 100 to 130 volts. External alarm: 1 per monitor. Contact rating 150 watts or 3 amp. non-inductive load. Indicator requires no electrical connections. Power and resistance reading is carried through reeled cord when plugged into jack in face of monitor.

- VERSATILE — NEW CONCEPT OF ZONE MONITORING ALLOWS YOU TO PUT MONITOR UNITS WHERE YOU NEED THEM
- EFFICIENT — WARNS YOU BEFORE TROUBLE STARTS
- DEPENDABLE — NO MOVING PARTS ELIMINATE WEAR
- ECONOMICAL — COSTS LESS THAN ANY OTHER TEMPERATURE MONITORING SYSTEM YOU BUY MODULAR UNITS ONLY AS NEEDED

As few as four, and as many as several hundred critical temperature spots can be monitored at one central control panel or from local zone panels in your plant . . . with Edison's OMNIGUARD. Hot bearings, or excessive temperatures in oil lines, air ducts, and chemical processes can be visually checked at any time at any spot in your plant.

Here's how OMNIGUARD can save you a lot of money with a minimum of effort: just as soon as a critical temperature occurs at a point anywhere in your plant, the mechanism is automatically shut off, a warning bell rings and a lamp flashes on the monitor panel. Instantly the trouble source is pin-pointed, checked, and remedied . . . well in advance of otherwise costly trouble.

This entire Edison monitoring system uses no moving parts, except for the alarm relay contacts. No electronic tubes or expensive wiring between components is necessary. The actual detection is done with Edison Resistance Temperature Detectors, which signal the warning to OMNIGUARD.

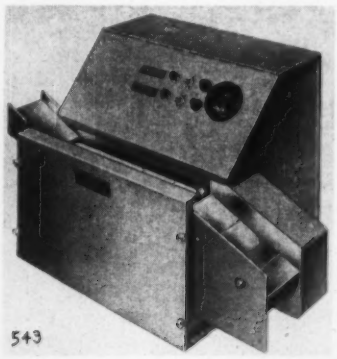
Edison's Omniguard brochure, #3036A, gives the entire story on temperature monitoring. Write for it.

McGRAW EDISON

Thomas A. Edison
INDUSTRIES
INSTRUMENT DIVISION
WEST ORANGE, NEW JERSEY

For more information circle **70** on inquiry card.

NEW INSTRUMENTS



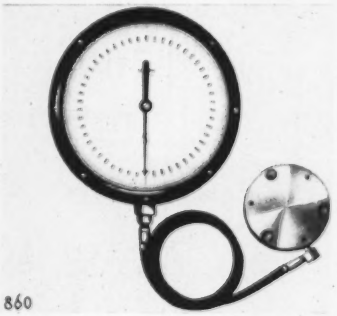
543

easily adjusted when changing from one package weight to another. Classifiers are custom-built; handle practically any shape of item.—*Toledo Scale Co., Toledo* 13, *Ohio.*

For more information circle **246** on inquiry card.

LOAD CELL SYSTEMS

New tension and compression load cell systems operate under adverse shock-loading and/or continuous vi-



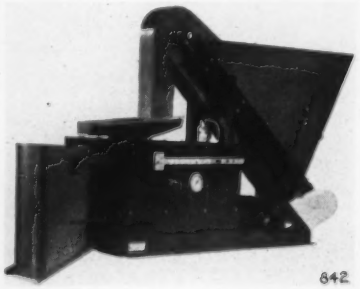
860

bration; require no external power source; feature automatic self-alignment under load.—*Martin-Decker Corp.*, 3431 *Cherry Ave., Long Beach* 7, *Calif.*

For more information circle **247** on inquiry card.

BELT WEIGHER

New Belt Weigher weighs tough materials that will not flow from hoppers; comprises a small storage bin from which materials are elevated by means of a belt on to a vibratory feeder that evens flow as it



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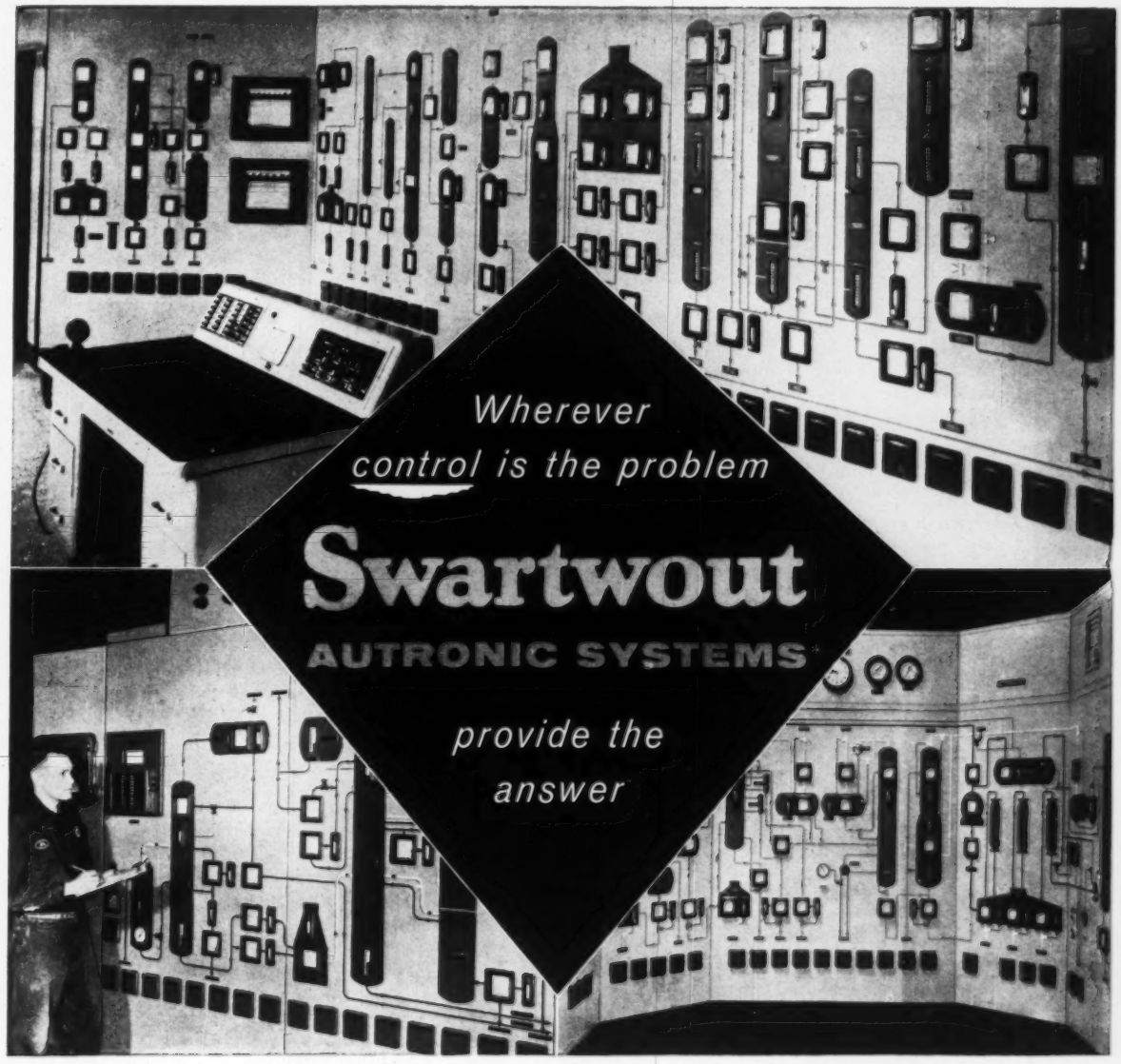


If control (and/or recording and/or indicating) is *your* problem, Autronic systems or components can provide the answer—rapidly, accurately, economically. For Swartwout Autronic systems are daily solving instrumentation problems *just like yours* in installations everywhere.

Refining . . . atomic . . . chemical . . . pipeline . . . food—in the United States, Canada and overseas—Autronic controls are rapidly obsoleting all other instrumentation systems.

You'll go all-electronic eventually—go Autronic now with Swartwout, pioneer and leader in miniature electronic controls.

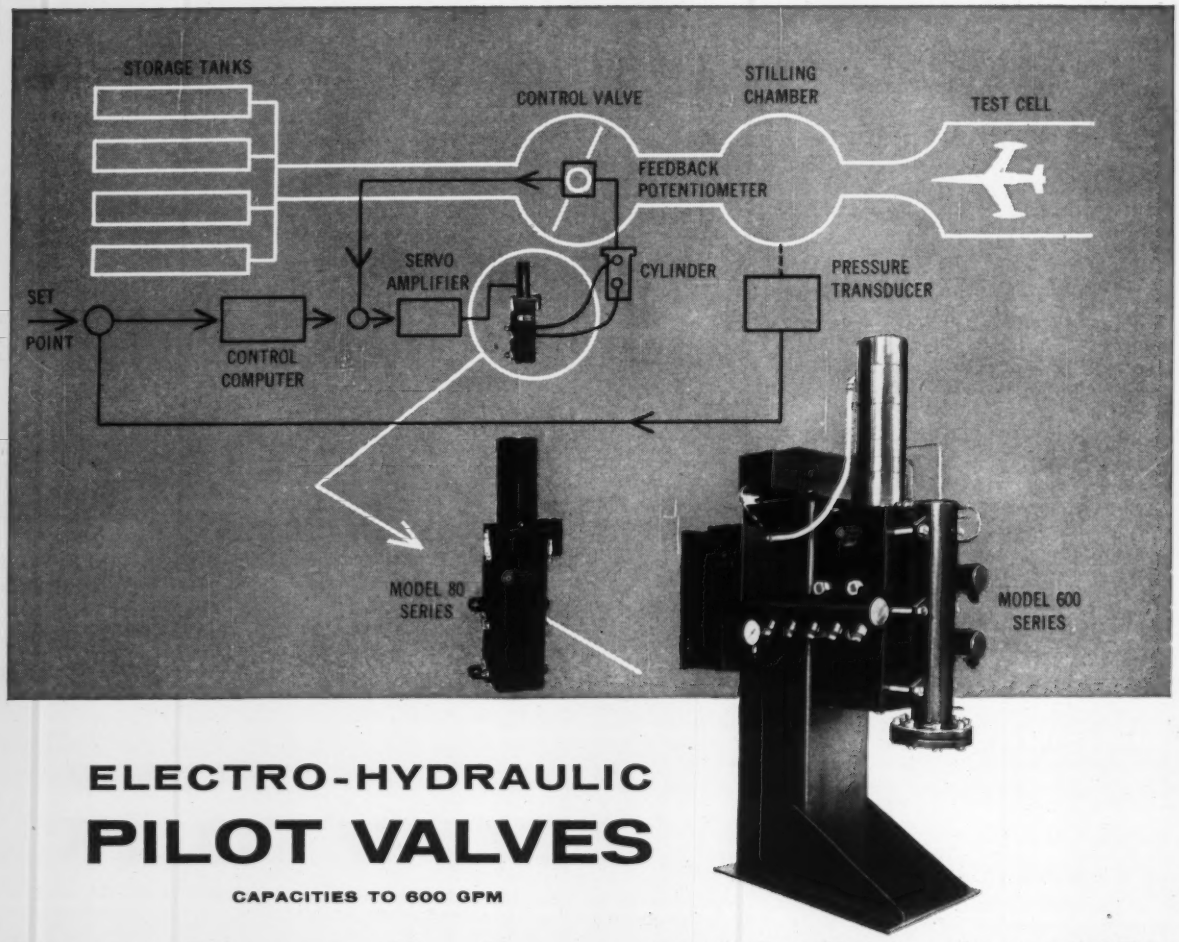
*Names of installations illustrated available on request. Or better still, call in your Swartwout representative for a consultation.

AA-4509

Swartwout *Autronic*® CONTROL SYSTEM

THE SWARTWOUT COMPANY • 18511 EUCLID AVENUE • CLEVELAND 12, OHIO

For more information circle **71** on inquiry card.



ELECTRO-HYDRAULIC PILOT VALVES

CAPACITIES TO 600 GPM

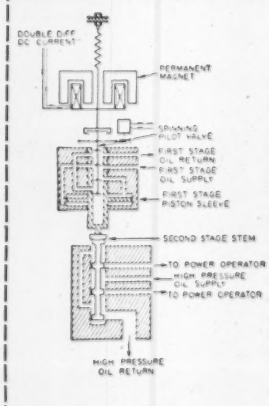
Frequency Response - to 10 cps - Accuracy - better than 0.1% - Hysteresis - less than 0.05%

Hagan PowrAmp Electro-Hydraulic Pilot Valves are dc actuated, permanent magnet motor driven, two stage servo valves used for the transfer and control of high pressure hydraulic fluid to power cylinders or motors driving dampers, valves, test models etc. As seen in the diagram at right, dc current inputs drive the first stage spinning pilot valve. This first stage hydraulic output drives the first stage piston-sleeve and the second stage high pressure stem.

Operating with supply pressures of up to 2000 psig and available in 18, 54, 80, 185, 369 and 600 gpm capacities at 2000 psi pressure drop, the Hagan Electro-Hydraulic Pilot Valve can control up to 300 usable hydraulic horsepower. Its permanent magnet motor and spinning pilot valve design provide virtually a frictionless and hysteresis-free valve as compared with the conventional iron core solenoid type of valve. The complete isolation of first and second stage valves allows the second stage to be applied in pneumatic service if desired.

This high power servo valve is a part of the Hagan "PowrAmp" line which also includes transducers for most key variables and electronic control computers. Available as separate components or as units of engineered systems, the complete line is described in Bulletin MSP-133, which will be sent on request.

For additional information on the Hagan Electro-Hydraulic Pilot Valve, write for Specification Sheet GH-300.



SPECIFICATIONS

Capacities—Up to 600 gpm at 2000 psi drop

Hysteresis—Less than .05% full valve stroke

Repeatability—Better than 0.1% full valve stroke

Closed Loop Frequency Response—1½ to 10 cps depending on model and load

Input—Double differential dc currents of ±50 ma. Resistance of each coil 500Ω. Maximum current, each coil, 100ma. Maximum voltage, 100 vdc.

HAGAN CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA
DIVISIONS: CALGON COMPANY, HALL LABORATORIES
IN CANADA: HAGAN CORPORATION (CANADA) LIMITED
OFFICES IN: MONTREAL, TORONTO, VANCOUVER, EDMONTON

For more information circle **72** on inquiry card.

carries material to a weigh bucket suspended on a graduated weigh beam.

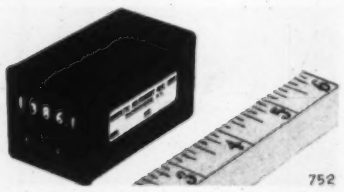
Several types of control units are available, all housed in remote control cabinets.—*Glengarry Processes Inc., Bay Shore, N. Y.*

For more information circle **248** on inquiry card.

TIME, FREQUENCY, SPEED, COUNTING

ELAPSED TIME INDICATOR

New miniature 400-cps elapsed time counter indicator is hermetically sealed, weighs 4 oz, features a



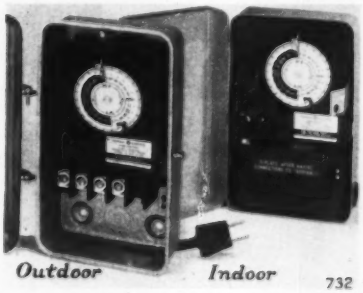
752

new type of low-speed synchronous motor and a unique 14,400:1 ratio gear train arrangement utilizing only 4 gears, whose simplicity maximizes reliability. Time range is 9,999.9 hours.—*Magnetic Instrument Mfg. Corp., Thornwood, N. Y.*

For more information circle **249** on inquiry card.

TIME SWITCHES

Two new time switches complete maker's general-purpose line, feature a 24-hour dial for up to 12 on-off



732

operations in one day, with trippers set as close as one hour apart. Outdoor model, TSA-41, is said to be industry's only regular-duty time switch with a truly raintight case at no extra cost. Indoor model, TSA-47, is available with dp and sp contacts; can withstand 350-amp inrush current.—*Instrument Dep't, General Electric Co., West Lynn 3, Mass.*

For more information circle **250** on inquiry card.

WRIST TIMER

New decimal calibration watch for engineers registers calibrations to 0.00001 min. Its face shows a minute

821

divided into hundredths; small dial registers up to 30 min to aid user in unobtrusive timing observations.—*Clebar Watch Agency, 15 W. 44th St., New York 36, N. Y.*

For more information circle **251** on inquiry card.

TIME INTERVAL, RATE, FREQUENCY AND RATIO METER

New Model 7370 Universal EPUT Meter performs ten operating functions including high-speed counting,

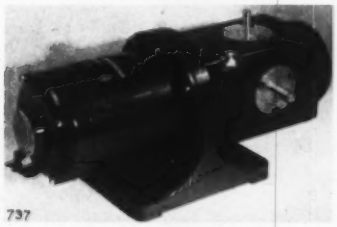
691

events-per-unit-time and time-interval measurements, frequency measurements up to 10 Mc accurate to ±1 cps, and various frequency ratio measurements. Time base is an oven-stabilized crystal-controlled 1-Mc oscillator followed by a series of dividers.—*Beckman/Berkeley Div., 2200 Wright Ave., Richmond 3, Calif.*

For more information circle **252** on inquiry card.

VARIABLE SPEED DRIVE

New Servotran mechanical variable speed drive, available with motors from 1/50 to 1/10 hp, has applica-



737

tions for coil winding machines process controls, etc., requiring manually- or automatically-operated infinitely-variable speed control. Control torque required is only 2 or 3 oz-in. Frequency response is such that reversing from full-speed forward to full-speed backward takes less than 0.05 sec.—*Humphrey, Inc., 2805 Canon St., San Diego 6, Calif.*

For more information circle **253** on inquiry card.

DATA READOUT COUNTER

New Data Readout Counters combine visual indication with electrical readout for remote indication, record-

SPAGHETTI SLEEVING

MADE FROM

TEFLON*

is Carefully Inspected and Controlled Dimensionally!

● PF spaghetti sleeving made from Teflon* is widely used for slip-on insulation, instrument tubing, bundle sheathing, medical tubing, pigtails and similar applications. It slips on easily, in long lengths up to 3 feet, can be used with tinned or bare wire rather than silvered and it wears longer. 25 sizes, 2 wall thicknesses, 10 colors in stock, 100% inspected and controlled dimensionally, are available, all with these important advantages:

- good dielectric strength (500 to 2000 volts/mil)
- lowest dielectric constant (2.0) and dissipation factor (0.0002) of any solid dielectric
- no change of electrical properties with temperature (—23°C to +230°C) or frequency (60 cycles to 100 mc)
- zero moisture absorption
- unaffected by any commercial chemical
- stress relieved for negligible shrinkage
- continuous service temperature of 230°C—intermittent to 300°C

Write, wire or call for further details and engineering assistance. Ask, too, for information on PF Teflon* flexible tubing, heavy-walled tubing and rod stock.

PENNSYLVANIA FLUOROCARBON CO., INC.
1115 N. 38th Street, Phila. 4, Pa. EVergreen 6-0603
*Teflon—DuPont trade name for Tetrafluoroethylene resin

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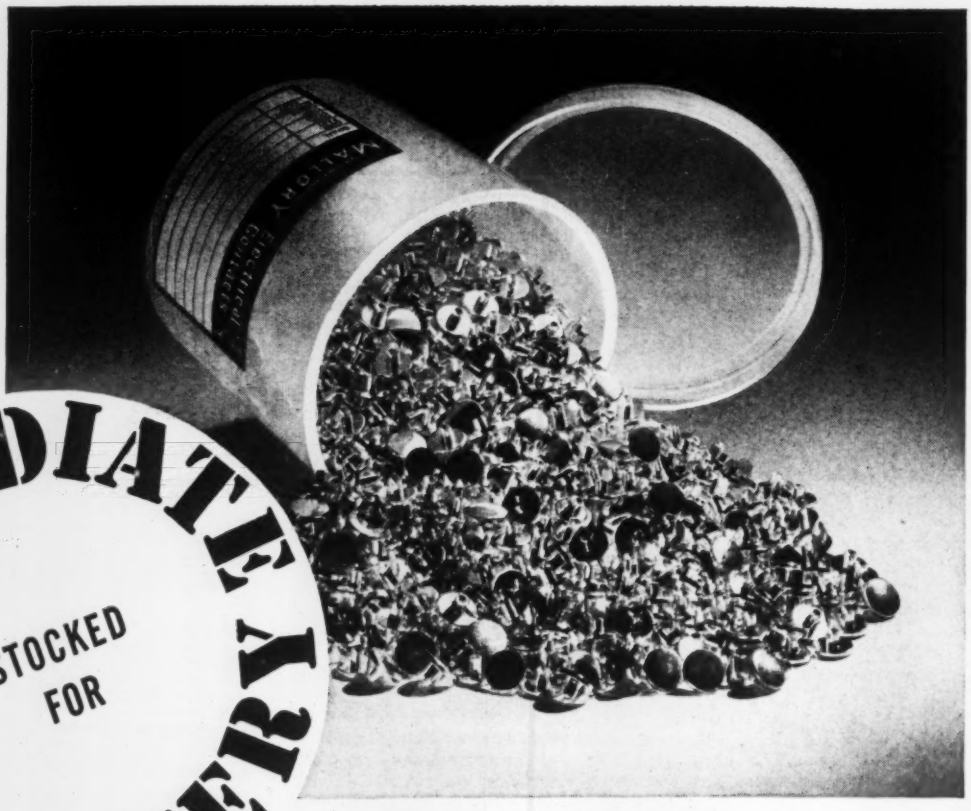

IMMEDIATE DELIVERY

STOCKED FOR

"Stocked for Immediate Delivery"—can be music to the ears of your production design engineers or purchasing agent.

Out of thousands of styles and sizes of fine-silver headed rivets as specified in customer orders came a list of 70 standard size contacts most frequently used. All 70 *standards* are "Stocked for Immediate Delivery" at Mallory.

For your new designs . . . check the Mallory "preferred list" for a size to fit your job. A Mallory standard can save engineering time . . . assure economical cost and prompt delivery when you go into production.

For your existing production lines . . . check the Mallory "preferred list" for a size closely matching the contacts you may now be purchasing on special order. A change to a Mallory standard may enable an appreciable cost savings on current and future production runs.

Write . . . or ask the Mallory representative for your copy of the Mallory Contact Division brochure 3-15A. It contains a complete stock list, dimensions, and pricing information.

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MALLORY

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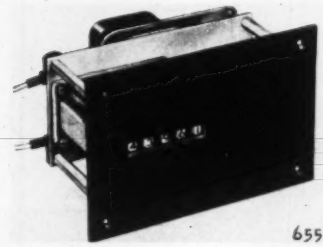


655

ing, and controlling applications. Shown: Form B-1538, electrically-actuated, electric reset, for 110-v ac/dc; automatically creates specific control-circuit contact closures for each number visually displayed. (Thus, with five-figure capacity, it provides 100,000 distinct circuit arrangements.) New counters are compatible with standard data processing equipment.—*Veeder-Root Inc., Hartford 2, Conn.*

For more information circle **254** on inquiry card.

NUCLEONICS

RADIATION MONITORING SYSTEM

New Model GA-3B self-contained radiation monitoring system is battery-operated; operates continuously

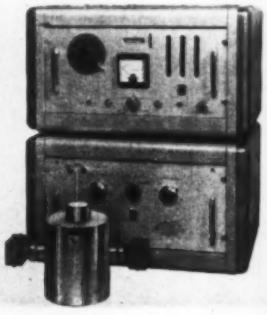
879

for 4 months or longer while being virtually maintenance-free except for battery replacement (2 each, RM 42). Gamma range from background 0.025 mr/hr to 100 kr/hr or higher in energy range from 80 kv to 1.5 mev.—*Riggs Nucleonics Co., 2390 Olive Ave., Altadena, Calif.*

For more information circle **255** on inquiry card.

CARBON-14 COUNTER

New Model DR-11 liquid phosphor scintillation counter for carbon-14 gives counting efficiency up to 80%



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AT LAST!

A Dryer Reactivated Without Heat!

NEW DEVELOPMENT OFFERS A DESICCANT TYPE DRYER SUPPLYING SUPER-DRY AIR OR GAS WITHOUT COSTLY, PROBLEM-MAKING HEAT!

Industrol, a leader in the field of dynamic dehumidification for over 10 years, introduces the new INDUSTROL HEAT-LES DRYER* with following advantages:

- 18 models available, handling flows from 2 to over 1800 standard cubic feet a minute.
- The units will provide effluent dewpoints of −100° F. to −140° F. continuously, regardless of even major fluctuations in the temperature of the gas or air.
- Installation costs reduced.
- Maintenance costs reduced.
- Effluent air or gas temperatures remain constant.
- Steam or electric heaters are not required, eliminating KW and steam consumption.
- Virtually all corrosion problems are eliminated.
- Explosion proofing costs may be eliminated completely.
- Outdoor installation is simplified.

Write today

FOR FREE INFORMATION AND SPECIFICATIONS OR CONTACT YOUR LOCAL TRINITY REPRESENTATIVE.

INDUSTROL DRYERS ARE MANUFACTURED BY

TRINITY EQUIPMENT CORPORATION

ROSELLE PARK, N. J. • CORTLAND, N. Y.

*PATENT APPLIED FOR

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FOR HIGHEST ACCURACY AND SENSITIVITY USE...

HASTINGS
AIR VELOCITY MEASURING INSTRUMENTS

MODELS COVER RANGES FROM 0 TO 200 M.P.H.

Hastings Jet-Vane is a rugged air velocity vane of solid cast aluminum for rooftop or tower installations. Range: 3-200 mph. Used with indicators or recorders.

DIRECT, INSTANTANEOUS READINGS . . .
UNAFFECTED BY TEMPERATURE VARIATIONS . . .
IDEAL FOR REMOTE INDICATION OR RECORDING.

Write Today for Complete Catalog Information

Hastings Horizontally Non-Directional Probe for accurately measuring extremely low range air velocities. Range: 0-30 mph. Expanded scale below 5 mph.

Hastings Model G Air-Meter. Velocity range: 0-6000 fpm. May be used ideally in usually inaccessible areas.

Hastings Model B Precision Air-Meter for measurements of highest accuracy. Dual-scale meter with range up to 20,000 fpm. Directional or non-directional probes.

HASTINGS-RAYDIST INCORPORATED
Hampton 25, Virginia

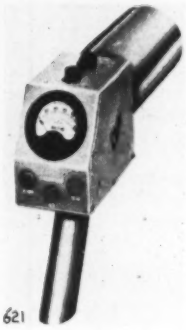
Manufacturers of Hastings Vacuum, Pressure, Velocity and Flow Measuring Instruments
Raydist Electronic Surveying, Tracking, Positioning and Navigation Systems

For more information circle **76** on inquiry card.

without need for refrigeration. It incorporates coincidence amplification and pulse height analysis so that background is only 15 to 20 cpm. It will count practically any sample soluble in organic solvents, or even water-soluble or insoluble.—*NRD Instrument Co., St. Louis* 19, *Mo.*

For more information circle **256** on inquiry card.

RADIATION MONITOR

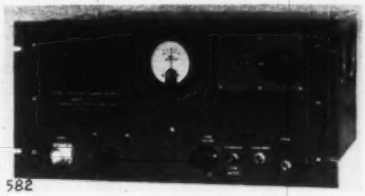


621

New Model 740 "Cutie Pie," for detection of alpha, beta and gamma radiation, meets requirements of Oak Ridge health-physics group but is suitable also for monitoring radiation sources and isotopes. Feature: when switching on, or changing ranges, it is ready for immediate use. Three models: Model A covers 25, 250 and 2500 mr/hr; Model B 50, 500 and 5000 mr/hr; and Model C 100, 1000 and 10,000 mr/hr.—*The Victoreen Instrument Co., 5806 Hough Ave., Cleveland* 3, *Ohio.*

For more information circle **257** on inquiry card.

H V POWER SUPPLY



582

New model N-413, for scintillation counting or ionization chamber work, is designed especially for use with the RCA 6810 photomultiplier tube and its 10-ma capacity enables it to furnish power simultaneously to several of these tubes for coincidence work. Output voltage ranges from less than 500 to 5000 vdc; regulation 0.005% for changes in both line and load; standard cell for reference.—*Hamner Electronics Co., Inc., P. O. Box* 531, *Princeton, N. J.*

For more information circle **258** on inquiry card.

LABORATORY EQUIPMENT

FLAME PHOTOMETER

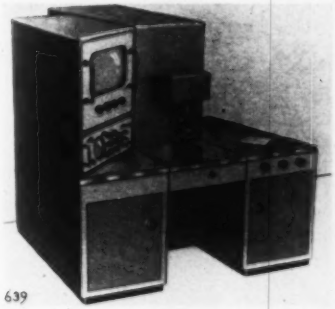
New Flame Photometer for Na, K and Li features low thermal drift and better repeatability by a new water-jacketed burner that eliminates IR heating of photocells. Photocells have 1000 times greater sensitivity than in older types and are impervious to water vapor or Hg. Hence, no lenses, galvanometers, or amplifiers. Instrument operates in tobacco smoke, dust, and drafts with a non-sealed, more stable flame.—*Advanced Instruments, Inc., 21 Oakcrest Rd., Needham, Mass.*

700

For more information circle **259** on inquiry card.

COLOR-TRANSLATING 'SCOPE

New Model ME-101 TV Ultraviolet Microscope and Microspectrophotometer is the first commercially-available instrument of its kind. Three UV (or visible) wavelengths are preselected. A color monitor presents in three primary visible hues these three UV absorption images. Microscope is essentially electronic, not overwhelmingly mechanical-optical as were previous models. Microspectrophotometry is performed by selecting any one of the horizontal scan lines and displaying its density variation (absorption) across the specimen on a line-analyzer oscilloscope.—*Neutronics Research Co., 165 Lake St., Waltham, Mass.*

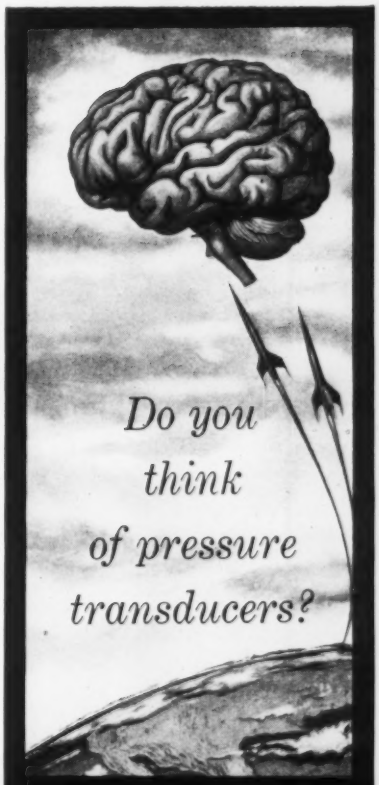


639

For more information circle **260** on inquiry card.

CHROMATOGRAPHIC ANALYSIS ADSORBENTS

New complete line of adsorbents for gas and vapor-phase chromatography includes a comprehensive selection of ready-to-use partitioning agents and properly-sized solid ad-



Guided missile manufacturers do...

For example, the General Electric Missile and Ordnance Systems Department uses Statham Model PA203 pressure transducers on their missile programs. The Model PA203 miniature pressure transducer mounts into a ¾-16 fitting without zero shift from installation torque. The transducing element is the rugged Statham unbonded strain gage. This model is available in ranges from 0-5 to 0-1,000 psia and is constructed to the exacting standards of sophisticated customers.

WHEN THE NEED IS TO KNOW... FOR SURE SPECIFY STATHAM

Please request Bulletin No. PA203

Statham
LABORATORIES
LOS ANGELES 64, CALIFORNIA

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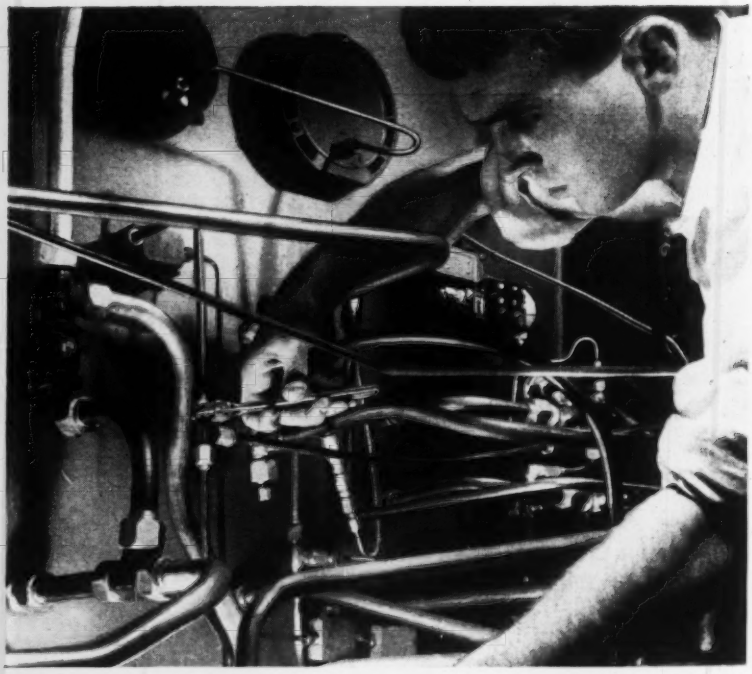
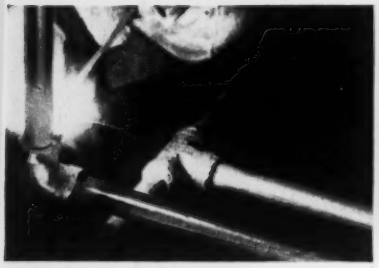
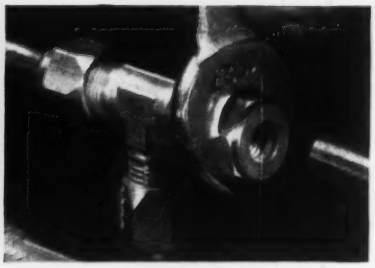


Fast, easy assembly with *Triple-lok* fittings even in close quarters, because of the low assembly torque. Yet *Triple-lok* remains absolutely leakproof under the severest conditions of vibration, high pressures and temperatures. *Triple-lok* is the flare fitting, famous for its sleeve — the industrial standard tube fitting. Meets specifications of the A.S.M.E. Code for Pressure Piping. Stocked in brass, steel, stainless steel, aluminum alloy. Made in other materials on special order. Send for Catalog No. 4310.

Easy-to-use Parker tube fittings for instrumentation and processing





Weld-lok. Easy to use. Simply insert tube, then weld. For extreme temperatures or corrosion conditions — wherever permanently welded joints are needed. Available in steel and stainless steel. Send for Catalog No. 4370.

Intru-lok. 3-piece flareless design fitting especially for instrumentation lines of ¼″ through 1″ O. D., copper or aluminum. Easy to install. Just insert tube, then tighten with regular wrench. Also for plastic tubing. Catalog No. 4324.

Warehouse stocks in industrial centers.
Ask your Parker-Hannifin Distributor — or write to:

TUBE AND HOSE FITTINGS DIVISION

Section 437-R, Parker-Hannifin Corporation, 17325 Euclid Ave., Cleveland 12, Ohio

Parker Hannifin
creative leader in fluid systems

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NEW INSTRUMENTS

sorbents, available to users of all makes of chromatographic apparatus. Advantages are a single convenient source of supply more comprehensive than any available elsewhere; and adsorbents packaged in uniform sizes and weights always available in even smallest quantities.—*Burrell Corp., 2223 Fifth Ave., Pittsburgh 19, Pa.*

For more information circle **261** on inquiry card.

MAGNETIC STIRRING HOT PLATE

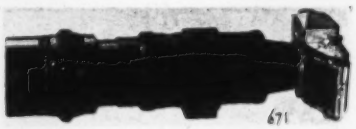
New Stir-Plate can stir and heat simultaneously or can do either operation alone; is abundantly ventilated and well insulated, whence cool operation of stirring motor. Stirring speed is variable; as high as 1140 rpm can be had in liquids of viscosity up to 140 centipoises. Sensitive thermostat provides stepless control over entire range to 700°F (371°C).—*Thermo Electric Mfg. Co., 536 Huff St., Dubuque, Iowa.*

For more information circle **262** on inquiry card.

PHOTOGRAPHY

TELEPHOTO LENS

Newly designed 400-mm (16″) f/5.5 Meyer Goerlitz Telephoto lens for 35-mm Exakta cameras has preset



diaphragm mechanism with 6 stops: f/5.5 to f/32; two engraved scales calibrated in feet and meters.—*Exakta Camera Co., 705 Bronx River Rd., Bronxville 8, N. Y.*

For more information circle **263** on inquiry card.

AUTOMATIC MOVIE CAMERA

New 8mm movie camera is the world's first in which light energy alone supplies the power which adjusts the lens: no batteries, motors or springs are used for exposure setting. User simply winds camera, sights and shoots. A photoelectric system sets the lens for proper exposure before

FOR MORE INFORMATION ON ANY OF THE PRODUCTS REPORTED IN THIS SECTION, CIRCLE THE ITEM NUMBER ON THE INQUIRY CARD BOUND IN THE BACK OF THIS ISSUE.

MEASURE

actual air velocity instantly with Alnor® VELOMETER

A simple, direct reading on the Alnor Velometer gives you an instant measure of air flow speed through grilles, ducts, furnaces, spray booths, or in the open.

Precision-built and self-contained, this portable instrument brings laboratory standards to the line or field installation. Available in a wide variety of scale ranges, full assortment of jets and fittings. You'll want all the facts (no safety department should be without a Velometer). Get Bulletin 2448-G. Attach this ad to your letterhead and mail to: Illinois Testing Laboratories, Inc., Room 518, 420 No. LaSalle St., Chicago 10, Illinois.

PRECISION INSTRUMENTS FOR EVERY INDUSTRY

Alnor

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AUTOMATIC ENGINE CONTROLS

- **FULL AUTOMATIC CONTROLS**
  For starting, stopping and protection.
- **D.C. SOLENOIDS**
  Continuous or intermittent.
- **RELAYS AND CONTACTORS**
  Power failure relays and engine cranking controls.
- **SPEED SENSITIVE SWITCHES**
  Overspeed and underspeed. 1, 2 and 3 element.
- **SPECIAL CONTROL PANELS**
  Control systems built to order.
- **SAFETY ALARM SETS**
  Visual and audible alarms for abnormal engine conditions.

SYNCHRO-START PRODUCTS, INC.
Since 1932
8151 N. RIDGEWAY AVE. • SKOKIE, ILL.

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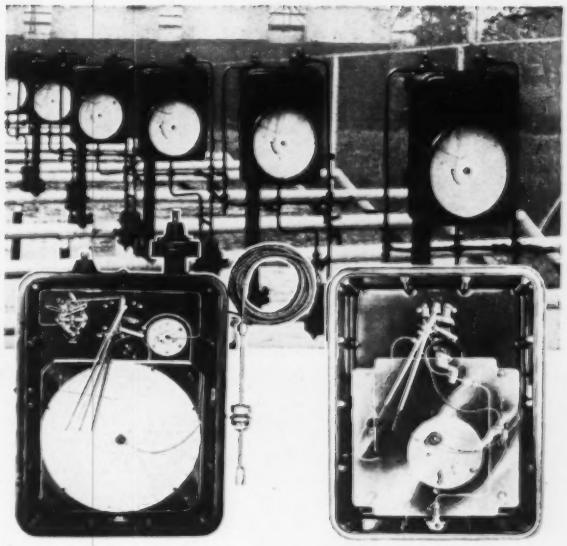
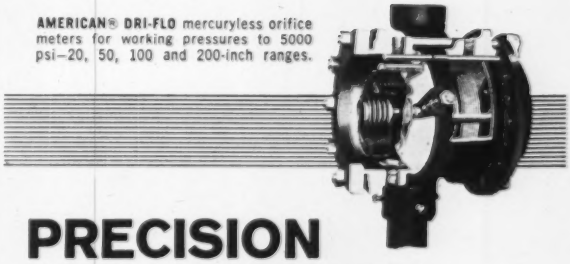


AMERICAN-WESTCOTT Series A-88 recording orifice meters for flow, pressure and temperature measurement—working pressures to 5000 psi—10, 20, 50, 100 and 200-inch ranges.

CANNON METER PENS for recording meters, available if desired, provide clear, legible chart records—hold up to a year's supply of ink.

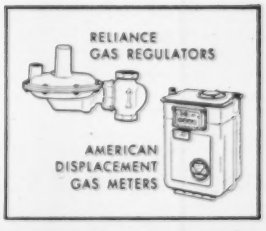
AMERICAN® DRI-FLO mercuryless orifice meters for working pressures to 5000 psi—20, 50, 100 and 200-inch ranges.



PRECISION MEASUREMENT

of flow, temperature, and pressure on one chart

Wherever precision measurement and economy of operation are required; at high or low flow rates, at varying temperatures, whether in recording, indicating, integrating or telemetering models, American orifice meters are synonymous with accurate, dependable, trouble-free service and low maintenance costs.



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SUPPLIERS TO THE GAS INDUSTRY for Ironcase, Tinned Steelcase, Aluminumcase and Welded Steelcase Meters • American-Westcott Orifice Meters Instruments • Reliance Regulators • Apparatus • Valves

For more information circle **81** on inquiry card.

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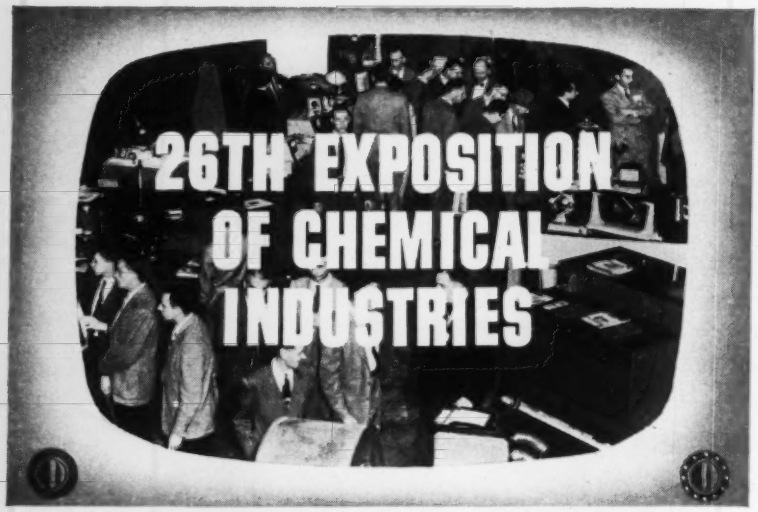

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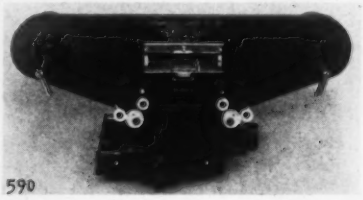
For more information circle **82** on inquiry card.

the starting button is touched. Lens iris is of a new type so sensitive that it moves at the touch of a human hair, yet is shockproof and has withstood severe environmental and field tests. Through use of thermistors, electric-eye mechanism adjusts also to temperature, so that camera can be used at any temperature extremes the film itself will withstand.—*Bell & Howell Co., Chicago, Ill.*

For more information circle **264** on inquiry card.

PROJECTION PLATE

New Model RN-4003 projection device is especially designed to mount on a Model M4005 Cooke Microscope;



will accept interchangeable film transport models T-400 and TF-400 in sizes from 8mm to 70mm. Control panel with remote control switch provides stop motion, single frame advance at 0.8 sec per frame and continuous cine-motion either forward or reverse. A frame counter assures accurate positioning of frame. Two strips of film can be transported simultaneously.—*Richardson Camera Co., Inc.*, 171 *W. Magnolia Blvd., Burbank, Calif.*

For more information circle **265** on inquiry card.

16-mm PROJECTOR

New Model 25B offers 20% more illumination than previous models and can be adapted for magnetic as well

as optical sound. Included as standard equipment is newly-developed Eastman Optical-Magnetic Pre-amplifier, which will accommodate signal output of a magnetic sound head as well as standard optical system.—*Cine-Kodak Equipment Sales, Eastman Kodak Co., Rochester 4, N. Y.*

For more information circle **266** on inquiry card.

Check and calibrate any type of thermocouple-actuated temperature instrument with one portable Pyrotest

Read temperatures or millivolts directly . . . without graphs, charts or conversion tables

The only portable potentiometer pyrometer with interchangeable direct reading scales

Pyrotest is 9 instruments in one, with 6 standard scales for thermocouples; 3 standard scales for millivolt readings. Special scales for any desired reading or use. Scales interchangeable in 30 seconds. Compact, rugged, easy to carry—12 lbs.; 12″ x 9″ x 8½″. Accurate to 1/6 of 1%. Self-contained power supply. Write for new bulletin 9B.

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For more information circle **83** on inquiry card.

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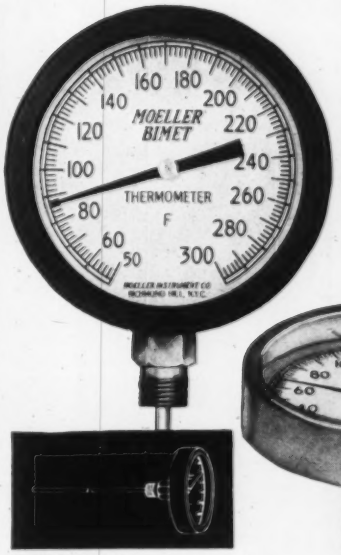

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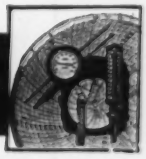

Gentlemen: Without obligation, please send me the new Moeller Bimet Thermometer Catalog No. 255C.

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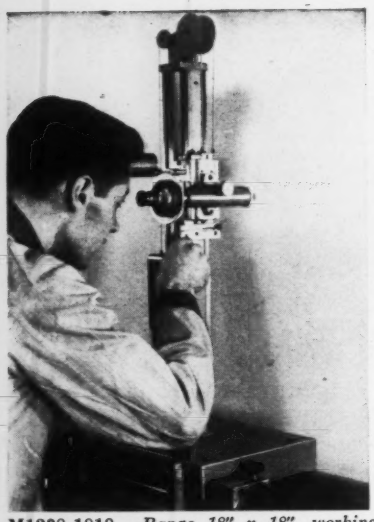
For more information circle **85** on inquiry card.



M1238-1818 — *Range 18" x 18", working distance 9" to infinity. Reads to 0.001" up to 24" working distance. Protractor ocular reads to 3 minutes of arc. Image is erect.*

Cut inspection time in half

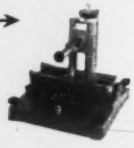
with new Gaertner Coordinate Cathetometers

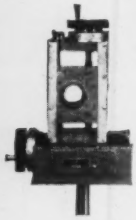
These convenient, reliable optical instruments permit making precise co-ordinate measurements in a vertical plane. The two dimensions are measured with one setting, object does not have to be rotated. Inspection time is cut in half and resetting errors eliminated.

Versatile Gaertner Coordinate Cathetometers are ideally suited for precision measurements on large objects; also objects or points in recessed, remote, or inaccessible locations. Applications include measuring jet engine sections, complicated castings, printed circuits, bolt holes and bosses on large piece parts, traces on cathode ray tubes, etc.

Because these are optical rather than mechanical measuring instruments, you make non-destructive measurements without contact, distortion, or concern about pressure being applied to the object when making a setting. Instruments available in English or Metric system.

M1236-46— Horizontal range 6", vertical range 4". Reads to 0.0001", working distance 5" to infinity.





M1236-22— Range 2" x 2", reads to 0.0001". Working distance 5" to infinity. Shown with 19 mm mounting rod, and without telemicroscope. Instrument permits precise coordinate movement of other objects such as photo cells, probes, etc., in place of telemicroscope.

Write for Bulletin 194-57

The Gaertner Scientific Corporation

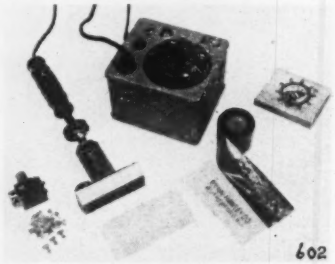
1211 Wrightwood Ave., Chicago 14, Ill.
Telephone: BUckingham 1-5335

For more information circle **86** on inquiry card.

SHOP EQUIPMENT and SUPPLIES

BRANDER

New Acrohex Brander No. 573 utilizes a temperature controller and has a thermometer mounted on its die

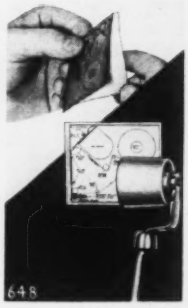


602

holder to enable user to always make perfect branded markings. (Some products are best branded at around 200°F; others at 800°F.)—*Acromark Co., 378 Morrell St., Elizabeth, N. J.*

For more information circle **267** on inquiry card.

METAL NAMEPLATES



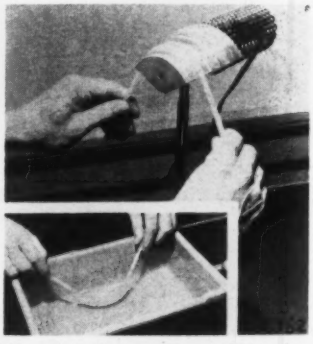
648

New Quik-Plates take only ten seconds to apply; are of deep-anodized self-bonding 0.004" aluminum with a permanent pressure-sensitive adhesive that requires no activation by water, solvent or heat and adheres instantly to metal, glass, plastic, etc.—*W. H. Brady Co., 727 W. Glendale Ave., Milwaukee 9, Wis.*

For more information circle **268** on inquiry card.

TUBING BENDER

New Permabender, for heat-forming permanent bends in Nylaflow pressure tubing (maker's new polyamide tubing) is expected to be of assistance where preformed symmetrical lines are required; has a heating element and mandrel with grooves to accommodate tubing sizes up to 3/8" OD.—*The Polymer Corp. of Pennsylvania, Reading, Pa.*



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INDUCTION FURNACE

New Type FIM-300 50-lb to 300-lb vacuum induction melting furnace features maximal flexibility in a wide variety of applications. It comprises an 8-ft long x 5-ft dia chamber, a 2900-liter-per-second diffusion-ejector pump, a 310-cfm mechanical pump, and a control center. Standard equipment includes two observation windows, a bridge breaker, and a sight tube. Two spare ball-and-socket joints are provided for use with such standard accessories as a thermocouple assembly, a sampling device, or an optical sight tube.—*Consolidated Electrodynamics Corp., Rochester Div., 1775 Mt. Read Blvd., Rochester 3, N. Y.*

For more information circle **270** on inquiry card.

ULTRASONIC GENERATOR

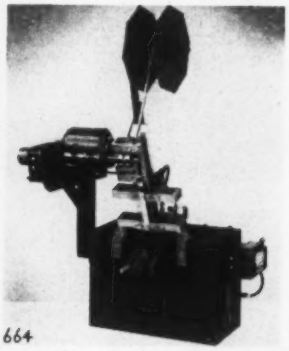
755

New M-203B Transducer is an extremely rugged low-cost high-power magnetostriction-type ultrasonic generator for industrial cleaning and degreasing applications; can operate continously with 400 watts input power; produces a sound pressure of 1,000,000 dynes/cm^2 in its vicinity when radiating into open water with 100 watts input to structure.—*Massa Laboratories, Inc., Hingham, Mass.*

For more information circle **271** on inquiry card.

AUTOMATIC TAPE REEL COMPONENT FEEDER

New Automatic Tape Reel Component Feeder, added to maker's Automatic Lead Bender, adjusts to both speed and size of components. Reels of up to 2,500 parts capacity can be automatically fed into Lead Bender, which handles up to 14,000 parts per hour and accommodates component body sizes up to 2" L x 1" D.—*Design Tools, Inc., 80 Washington St., New York, N. Y.*



664

For more information circle **272** on inquiry card.

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Small Motors

"Most adaptable and reliable motor available for Hewlett-Packard Oscillator"

W. N. Eldred, Hewlett-Packard Company, Palo Alto, California

Hewlett-Packard Company's Model 670 swept-frequency oscillator incorporates the unique feature of an automatic, adjustable mechanical frequency sweep. To drive the tuning dial and sweep it over any desired frequency range, the Barber-Colman Type OYAZ reversible motor was chosen. "Found it the most adaptable and reliable unit available for this application," reports the manufacturer. For precise actuation of your products, too, there's a wide selection of Barber-Colman small motors up to 1/20 hp. Unidirectional, synchronous, and reversible . . . with or without gearing . . . open or enclosed. Write for catalog F-4271, or see Sweet's Product Design file.

BARBER-COLMAN COMPANY

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For more information circle **87** on inquiry card.

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HOKE TOGGLE VALVES

A flip of the handle is all it takes to open or close a Hoke toggle valve, providing fast, positive control on gas or liquid lines at pressures up to 1000 psi. Seats and stem seals are tight enough for most vacuum work. For instrument panels or test stands, in angle and globe patterns of brass or stainless. Sizes ⅛" through ½", handles are colored for quick identity. Complete data is yours for the asking.

HOKE

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Fluid Control Specialists
231 S. DEAN STREET, ENGLEWOOD, N. J.

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new B & F Strain Gage Control Unit permits

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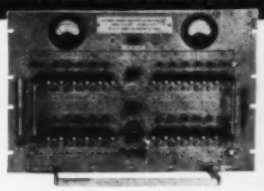
FASTER . . . EASIER . . . MORE ACCURATELY



B & F Bridge-Balance and Calibrating Unit, Model 24-202, is a precision-built instrument for the balance, control and SERIES calibration of strain gages, accelerometers, pressure pickups and other resistive-type transducers.

Proving invaluable today in missile range instrumentation systems and flight test programs of advanced military aircraft, the Model 24-202 eliminates the need for "averaging through" calibration pulses or "fairing" zero and base line references.

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Independent adjustment for each channel of:

- VOLTAGE—(Individual Channel Control Switches)
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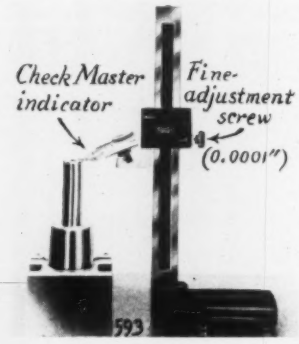
DIMENSIONAL GAGING and INSPECTION

HEIGHT GAGE

New special Check Master Height Gage, a companion device for use with maker's new Check Master test

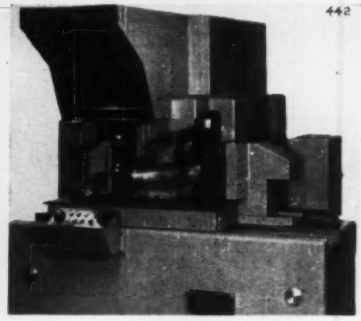


indicator, is adjustable to consistent "tenth" accuracy.—*Standard Gage Co., Inc., Poughkeepsie, N. Y.*

For more information circle **273** on inquiry card.

TRACER-TYPE PROJECTOR

New English-made Model OR-1500 Projection Pantometer, for inspection of turbine blades (etc.) up to 24" long and 6" chord, features provisions for checking contour and size of any predetermined section and also section displacement and twist. Principles: (1) optical reproduction of path of stylus follower, using two diametrically-opposed styluses each mounted on slides and connected to an objective lens; (2) use of separate graticules on all blade sections to be checked; (3) use of a tolerance graticule; (4) use of two postional indicators with two "spot" graticules for displacement or twist.—*Bentley Industrial Corp., 41 E. 42nd St., New York 17, N. Y.*



For more information circle **274** on inquiry card.

BATTERY-POWERED ELECTRIC GAGING SYSTEM

New electronic system of precision measurement is based on use of Electro-Probe, a small hermetically-sealed

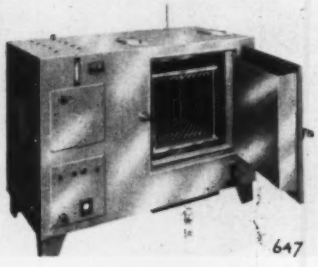
gage head whose output is said to maintain "such exact linear relationship to contact movement that available electrical instruments have not had sufficient sensitivity to measure the error."—*Federal Products Corp., 1144 Eddy St., Providence 1, R. I.*

For more information circle **275** on inquiry card.

MECHANICAL TESTING

AGING-TEST OVENS

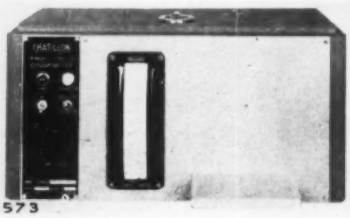
New Con-Wate Mechanical Convection Aging Oven in ranges to 180°C with Power-O-Matic Control to 0.5 C° are designed specifically for certain ASTM tests involving accelerated aging at controlled temperatures. From 49 to 240 samples can be suspended at one time in special stretch suspension rack which can be removed. Four standard sizes from 1 to 10 cu ft; all wiring complete and meets NEC as amended.—*Blue M Electric Co., Blue Island, Ill.*



For more information circle **276** on inquiry card.

RUNNING-TORQUE TESTER

New 100RT Series, for testing subfractional-hp motors, has 3 sets of interchangeable springs with 0.1, 0.5 and 2 oz-in capacities; dial graduated from 0 to 100 in increments of 1; ac-



Pete Marenholtz discusses PREFLIGHT MISSILE CHECKOUT

Prior to launching a missile, a full-scale dress rehearsal is conducted in order to enact every predictable contingency which might occur during flight. Considering the multitude of intricate and remotely controlled actuations which must be checked within a very short time interval, and the speed with which the corresponding decisions must be made, it is easy to recognize the need for the faster-than-human, more-reliable-than-human capabilities of the equipment monitoring this dress rehearsal. The possibility of human errors can not be tolerated, not only out of concern for the safety of personnel, but in order to avoid damaging the expensive missile itself.

The preflight missile checkout system incorporates all operations necessary for the final preparation of the missile for flight. To meet the requirements of unfailing high-speed repeatability, the use of electronics is mandatory. The electronic checkout equipment must:

1. Position missile controls for flight and precess inertial guidance elements for a predetermined flight plan. This involves making decisions which may be changed again during the final seconds prior to the moment of launching. Errors in judgment or of actuation must be eliminated.
2. Actuate all controls on the missile and sense correct functioning.
3. Provide an immediately available record of all tests for evaluation and making of final decisions relating to the missile's readiness for firing.

The mechanics of performing the above checkout functions falls into the realm of logical decisions. More specifically, the decisions are made more reliable and accurate by resorting to electronic decision elements. One technique is to store into a memory device all the necessary commands, off-limit conditions, and sequencing instructions required for the checkout.

The type of memory device required for a particular missile depends upon the speed with which checkout operations must take place. For instance, present-day missile checkout time scale requirements may be satisfied with punched paper tape programs. Faster access time, if required, may be achieved by employing magnetic tape or magnetic cores.

In a typical system the selection of controls to be actuated and electrical points to be instrumented is accomplished by positioning stepping switches in response to signals generated by the program memory device. The signal from the instrumented point is converted to a digital signal and compared in an automatic comparator with predetermined limits likewise stored in the memory device. This comparator operates as a time-digital comparison and comparisons therefore can be made at high speed and with digital accuracy.

A prime requirement for an automatic checkout system is absolute reliability. The time and the money at stake are enormous and reliability of the ground station system should, if possible, exceed that of the missile itself by at least an order of magnitude. In the case of equipment carried on board the missile it is often necessary to compromise between reliability and weight. But ground station equipment is invariably designed for reliability regardless of weight.

Pete Marenholtz, engineer, specializing in transistor digital circuitry, discusses automatic preflight missile checkout.

Redundancy is used (over and above conservative design and quality components) in achieving this extreme degree of reliability. Each internal operation of the system is performed twice and the results are compared before initiation of a main missile system function. A malfunction anywhere in the checkout which could not otherwise be avoided, is therefore immediately detected and measures are taken to protect the overall missile system. In the binary portions of the system parity checks are employed for added reliability insurance.

In developing such systems as the preflight missile checkout system, the progressive nature of military research has advanced automation techniques to their present high level and has paved the way for their counterpart in industrial applications.

By applying the latest proven techniques, our well-qualified staff at Daystrom Systems is prepared to take single responsibility of assembling and installing a system to meet your needs. We are currently compiling a file of new applications and papers on various parts of systems, both industrial and military. If you are interested in receiving the file and periodic additions, please write us.

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For more information circle **92** on inquiry card.

WHO IS BORG?

George W. Borg, who founded this corporation, is the "Mr. Clutch" who started with Borg & Beck. He then helped organize the Borg-Warner Corporation of which he became president. Later he served as chairman of the board until he resigned to devote his full attention to The George W. Borg Corporation.

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For more information circle **93** on inquiry card.

NEW INSTRUMENTS

curacy within 1% of each capacity. Feature: Tempruf extension springs mounted on a lever connected with a hysteresis brake; differential transformer introducing no frictional error or drag since there is no contact between its moving sufaces.—*John Chatillon & Sons, 85 Cliff St., New York 38, N. Y.*

For more information circle **277** on inquiry card.

ALTITUDE-TEMPERATURE TEST CHAMBER

New low-cost AT-108 Series provides three functions: (1) combination chamber for altitudes to 200,000

753

ft with temperatures from −100°F to 400°F; (2) altitude chamber which lifts out to operate separately at ambient temperatures with altitude simulation up to 200,000 ft; (3) high-low temperature chamber with range from −100°F to 400°F which operates independently after removal of altitude simulation unit.—*Mantec, Inc., 126 Maryland St., El Segundo, Calif.*

For more information circle **278** on inquiry card.

HI-LO TEMPERATURE TEST CHAMBER

Model DI-3 Dry Ice Test Chamber with 18x18x18" test space covers temperatures from −100°F to 300°

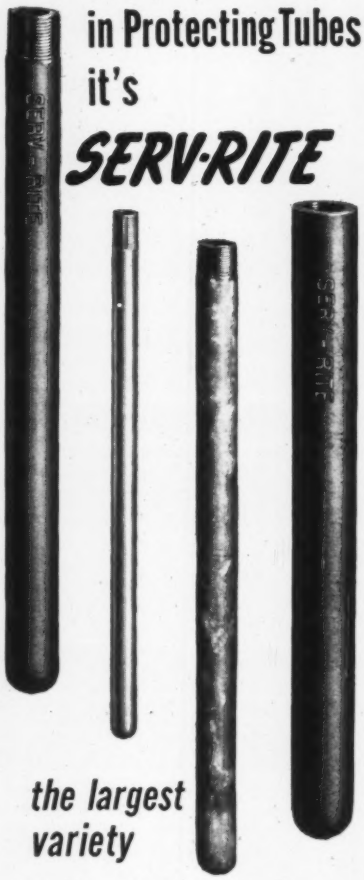
728

F; features low-mass microhm heating unit and dry-ice cooling with bypass damper for economical operation; has a readily-accessible separate compartment for controls and instruments. Accessories available are multipane windows, added penetrations, temperatures to 425°F or higher and casters for portability.—*Environmental Equipment Co., 369 Linden St., Brooklyn 27, N. Y.*

For more information circle **279** on inquiry card.

for any requirement in Protecting Tubes it's

SERV-RITE



the largest variety

In size and length, in iron, nickel, and alloys, and in formed or precision drilled, Gordon has about the largest variety of thermocouple protecting tubes. And you get off-the-shelf delivery on most any of this great variety of "standard" tubes. Gordon also makes protecting tubes to specifications for special requirements.

Give Serv-Rite a trial on your next protecting tube requirements. You can't go wrong. Careful manufacture and rigid inspections assure satisfaction. Get full information today. Ask for Bulletin 11-13.

● Bulletin 11-13 gives general application data, specifications, and ordering information on Serv-Rite protecting tubes and protecting wells—the largest grouping in one listing.

6221

CLAUD S. GORDON CO.
Manufacturers · Engineers · Distributors

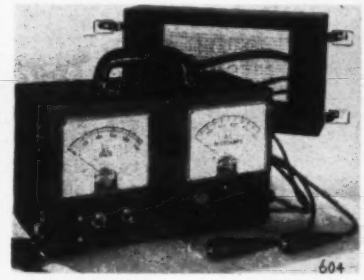
609 West 30th St., Chicago 16, Ill.
2025 Hamilton Ave., Cleveland 14, Ohio

For more information circle **94** on inquiry card.

ELECTRICAL TESTING

INSULATION ANALYZER

New portable (16 lb) Model 122 quickly checks insulation for resistance, power factor, and breakdown



strength; features a sensitive voltmeter, a dual-range leakage microammeter, compensator for cancelling capacitance effects, continuously-variable testing voltage, high sensitivity arc detector, and limited current output for safety. Requires no warm-up period.—*Slaughter Co., Piqua, Ohio.*

For more information circle **280** on inquiry card.

INDEX STANDS

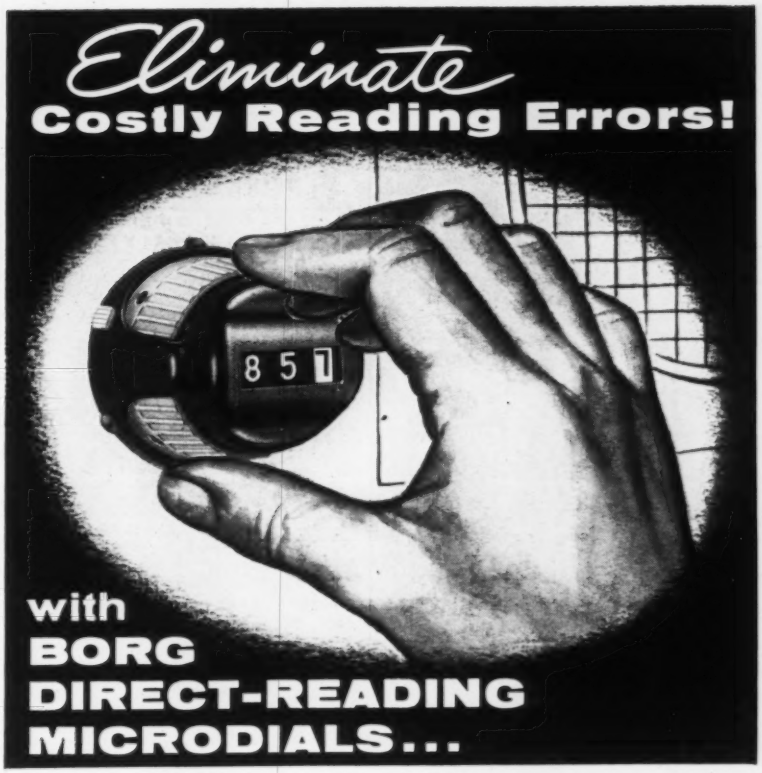
New KTC 4277288-1A-A with 5° resolver bridge, and KTC 427288-1B-B with 5° synchro bridge, have bridge

mechanically connected to stand so that correct angular relationship is maintained for all positions of indexing wheel. This minimizes test time, operator fatigue and possible error.—*Kearfott Co., Inc.,* 1378 *Main Ave., Clifton, N. J.*

For more information circle **281** on inquiry card.

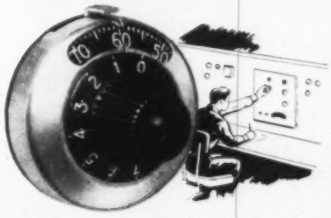
TEST OSCILLATOR

New portable Model 21A pushbutton test oscillator, featuring all-transistor circuitry, printed wiring, and



Large, clear numbers are easily and accurately viewed through the curved, one-piece window of Borg Direct-Reading Microdials. The in-line digital presentation practically eliminates reading and setting errors . . . especially under the difficult conditions of forced fast reading and setting. Human engineering studies have determined that the greatest accuracy of perception of precise numerical values is provided by an in-line digital presentation. Borg Microdials are designed to take maximum advantage of this fact. Available in 3, 4 and 5 digit models.

CONCENTRIC SCALE MICRODIALS



Borg Concentric Scale MICRODIALS indicate the position of any multi-turn device of 10 turns or less.

Borg Concentric Scale MICRODIALS are precision dials with an indexed accuracy of one part in 1,000. They indicate the position of any multi-turn device of 10 turns or less. Concentric scales indicate full turns and increments. Finger-tip brake retains any setting. Knob fastens directly to shaft . . . no backlash. Accurate . . . easy to install.

Write For Complete Data On All Borg Microdials
Ask For Catalog BED-A56

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

ELECTRONIC – MECHANICAL BORG EQUIPMENT

Built by Borg

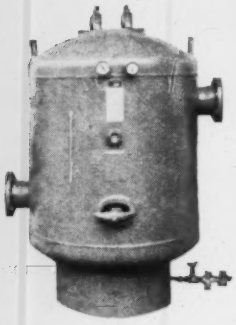
MOTORS
MICROPOTS
MICRODIALS

For more information circle **95** on inquiry card.

AUTOMATIC REMOVAL

MOISTURE VAPOR HUMIDITY

FROM COMPRESSED AIR



Van-Air® DRYER

Unique in moisture-control, Van-Air Dryers do more than trap condensed liquids from compressed air lines. They remove vapor-humidity to *LOW DEW POINTS* besides eliminating water and solid impurities from raw compressor air.

Van-Air Dryers eliminate elusive trace vapors that condense at line-extremity temperatures and cause untold product spoilage, instrument failure and operational down-time. Where air must be of clean, dry, instrument quality as in automation, product finishing, processing foods, chemicals, plastics, etc., these Dryers are proving highly efficient—*AND*, they work for pennies instead of dollars. Available in many capacities up to 5000 SCFM and pressures up to 3000 psi. Van-Air Dryers are used by hundreds of plants from coast to coast.

When air-line moisture is a problem in your plant, Van engineers will be glad to help. Write or phone collect—Erie 3-5556. Meanwhile, ask for useful handbook, "Air, Water and Industry."

SEND FOR BROCHURES OF

Van-Air and Vi-Speed

PNEUMATIC EQUIPMENT

SHOWING UNIVERSAL AIR CYLINDERS, BENCH-TYPE and DEEP-JAW AUTOVISES BENCH and ARBOR PRESSES ENGINEERED FOR AUTOMATION BY

VAN PRODUCTS CO. • MFRS.
5807 SWANVILLE ROAD, ERIE, PA.

For more information circle **96** on inquiry card.

NEW INSTRUMENTS

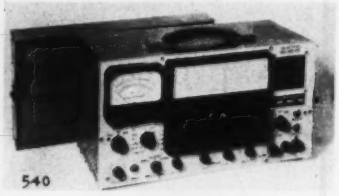
self-contained power supply, is designed specifically to expedite repetitive-type operations. It provides 8 preset frequencies (user-specified) between 15 cps to 150 kc at a source impedance of less than 0.5 ohm.—*Consolidated Electrodynamics Corp., Electra Div., 325 N. Altadena Drive, Pasadena, Calif.*

For more information circle **282** on inquiry card.

ELECTRICAL and ELECTRONIC INSTRUMENTS

WAVE ANALYZER

New Model 217OC Selective Voltmeter employs heterodyne principle with balanced modulation and highly



selective crystal filters for frequency and voltage measurement. Direct reading, calibrated for dbm or rms voltages, range −80 dbm to +32 dbm, accuracy ½ dbm; tuning range 1 to 200 kc.—*Rycom Instruments Div. Railway Communications, Inc., 9351 E. 59th St., Raytown, Mo.*

For more information circle **283** on inquiry card.

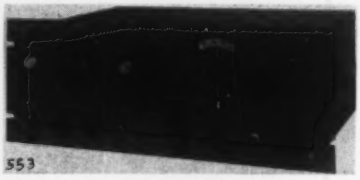
HIGH-TEMP AC VTVM

New 121 Series single-range ac VTVM withstands exposure to temperatures as high as 85°C; maintains 2% f-s accuracy to 71° C; is said to be ideal for military applications. Input impedance 1 megohm, frequency range 20 to 50,000 cps; any range from 30 mv to 300 vac.—*Trio Laboratories Inc., 4025 Merrick Rd., Seaford, N. Y.*

For more information circle **284** on inquiry card.

NULL INDICATOR

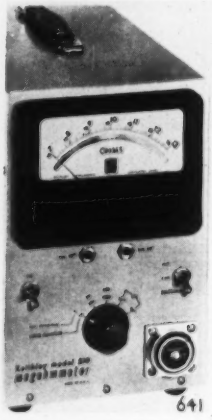
New Model 510R Phase Sensitive Tuned Null Indicator is a new type of instrument which combines high-gain



high-selectivity tuned amplifiers with precise phase detectors and a combined display indication of both in-phase and quadrature voltage components.—*Gertsch Products, Inc., 3211 S. La Cienega Blvd., Los Angeles 16, Calif.*

For more information circle **285** on inquiry card.

MEGOHMMETER

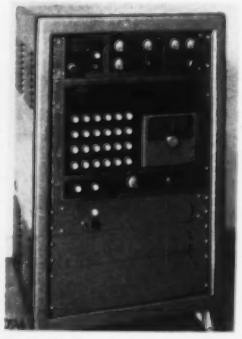


New Model 510 combines high sensitivity of electrometers and convenience of a single 6″ mirror scale; measures 10^7 to 10^{15} ohms without range-switching. Compression of high end of ohmmeter scale has been eliminated and accuracy within 1% of full scale is maintained at every point on scale.—*Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, Ohio.*

For more information circle **286** on inquiry card.

SPECTRUM ANALYZER

New Spectrum Analyzer analyzes any complex electrical waveform continuously within its frequency range.



(Frequencies available from 0.5 to 20,000 cps, others in special order). It presents a readout showing frequencies included in waveform and amplitudes of each of the frequency Components. Waveforms can be continuous or discontinuous. Analysis is performed over successive 10-second periods (other periods on special order). Readout is a bar graph produced by a pen writing galvanometer. Long-term stability is better than 2%. Four types of analysis are available. Standard model covers 24 bands by selection of plug-in filters.—*Edin Co., Inc., 207 Main, Worcester 8, Mass.*

For more information circle **287** on inquiry card.

Here E. V. Stearns (left), Inertial Guidance Department Manager, and G. D. Schott, Flight Controls Department Manager, discuss preliminary design of guidance and control systems.

Lockheed Missile Systems announces...

NEW POSITIONS IN INERTIAL GUIDANCE

■ Few areas of science or engineering equal inertial guidance in growth or the need for continuing advances.

It is a field of major effort at Lockheed Missile Systems. Weapon systems management programs include all phases of inertial guidance and navigation.

Continued expansion in these programs has created a number of new positions, involving:

Mechanical design of precision instruments such as gyros and accelerometers, giving extreme attention to size, weight, susceptibility to environment and related factors;

electronics circuit design, using miniaturized and solid state techniques;

design of precise computing systems for data handling within the guidance system;

theoretical analysis and study of guidance problems to relate the dynamics of a vehicle in a defined flight path or trajectory to a prescribed mission or objective of the larger weapon system;

theoretical analysis to determine performance of guidance systems and to optimize their design;

analysis and prediction of component performance through application of theory, study and laboratory testing;

design, development and construction of specialized testing equipment in which celestial and terrestrial motions form the basic reference for measurement;

manufacturing development of inertial components such as gyros and accelerometers.

Those possessing a high order of ability and experience are invited to write the Research and Development Staff, Palo Alto 1, California.

Engineers who lack experience in inertial guidance but wish to participate in its growth are invited to write.

Lockheed

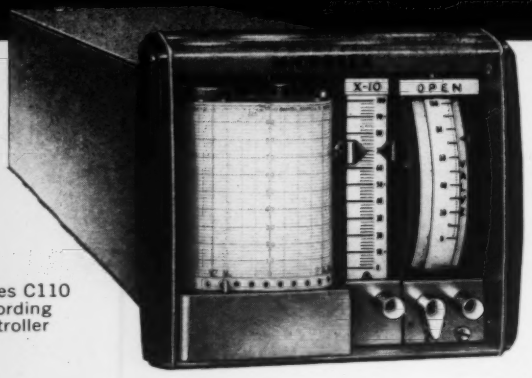
MISSILE SYSTEMS

A DIVISION OF

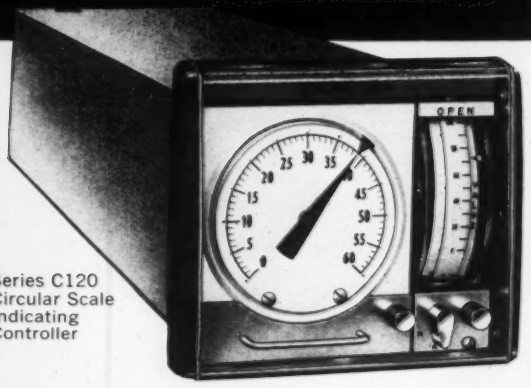
LOCKHEED AIRCRAFT CORPORATION

PALO ALTO • SUNNYVALE
VAN NUYS, CALIFORNIA

NEW TRANSISTORIZED ELECTRONIC CONTROLLERS Interchangeable for complete versatility



Series C110
Recording
Controller



Series C120
Circular Scale
Indicating
Controller

The new 'American-Microsen' Series C100 Electronic Controllers can be interchanged at the panelboard in seconds. A recording controller to an indicating type . . . a proportional-action controller to proportional-plus-reset . . . slow reset to fast reset – any of these replacements is quickly made by pulling one unit out and plugging in the other.

The controller settings of the 'American-Microsen' System are all calibrated and repeatable. When a controller station is replaced, the proportional, reset and rate settings can be made in advance so the process is on control the instant the changeover is completed. No playing around to tune in the control.

When the process is on manual control during a replacement operation, the controller station stays in balance with the actual valve position. Thus the process can be changed back to automatic control without "bumping" or upset. A unique feature of the 'American-Microsen' System eliminates any "balance" or "seal" position between manual and automatic.

These are but a few of the many functional advantages of the new 'American-Microsen' Electronic Control System. Join the many satisfied users of this new approach to process control. Make certain you have the better control and simplified servicing so essential to higher product quality and greater operating economy. Arrange for a meeting with one of our sales engineers to determine the best equipment for your service. *Write for Bulletin RC100.*

Controller Performs These Functions

Measures input signal from transmitter and records or indicates in terms of the measured variable — pressure, temperature, flow, etc. (The Series C110 records on a 3-inch wide strip chart, the Series C120 indicates on a 4-inch diameter scale.)

Provides means of setting the desired value of the measured variable (set point) and compares actual value with desired value.

Transmits control signal, incorporating proportional, reset, and/or rate actions to operate final control element.

Provides means to operate control element manually with simple switch and manual knob.

Ultra-Modern Features Provided

All functions of recording (or indication), controlling (proportional, reset, and/or rate), and manual valve operation *in a single housing.*

Transistorized controller station for ultimate reliability and long service life.

Printed circuitry and miniaturized components for space-saving simplicity.

Plug-in units for complete interchangeability and ease of maintenance.

Ratio, cascade, and other similar control arrangements, using standard instruments.

Direct bumpless transfer from manual to automatic control with no intermediate position.

DC signals of 1.0 to 5.0 milliamperes for instantaneous distance transmission up to 30 miles.

Controllers are compatible with any unit of other manufacture using the standard 1 to 5 milliampere DC signal.

MANNING, MAXWELL & MOORE, INC.

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

INDUSTRIAL CONTROLS DIVISION • STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN-MICROSEN' ELECTRONIC INSTRUMENTS FOR MEASUREMENT, TRANSMISSION AND CONTROL

For more information circle **97** on inquiry card.

ELECTRICAL-INSTRUMENT ACCESSORIES

MASTER SCANNER MODULE

New Master Scanner Module, to be used with maker's modular instruments, permits automatic scanning of

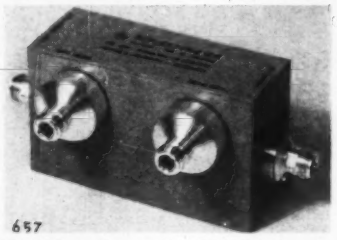
557

100 input channels, digitally displays the number of the selected channel. When combined with slave modules of 300 channels each, any number of channels can be selected. Scanning time is 0.1 sec per channel.—*Electro Instruments, Inc.*, 3794 *Rosecrans, San Diego, Calif.*

For more information circle **288** on inquiry card.

REFLECTOMETERS

Two new reflectometers permit matching a load to a transmission line, or measurement of reflection co-


657

efficient, to be accomplished accurately and conveniently over a frequency range of 10 to 2400 Mc. Type FT-ZUP covers 10 to 600 Mc; Type FT-ZDP 300 to 2400 Mc.—*Federal Instruments, Industrial Products Div., Int'l T&T Corp.*, 100 *Kingsland Rd., Clifton, N. J.*

For more information circle **289** on inquiry card.

CONSTANT VOLTAGE TRANSFORMERS

Five new static-magnetic regulators for stabilizing voltage supply to 6.3-v filaments are designed for simple

772

mounting as product components in place of conventional unregulated filament transformers.—*Sola Electric Co.*, 4633 *W. 16th St., Chicago* 50, *Ill.*

For more information circle **290** on inquiry card.

MINIATURE CHOPPER

812

New Syncroverter Chopper with a center-tapped coil should prove useful in special driving circuit applications, such as flip-flop, push-pull, or pulsed type. Same contact ratings and high degree of reliability in dry circuit applications as maker's standard Syncroverter Chopper. Because of coil construction, it can be used also as a polar relay or as a true differential relay.—*The Bristol Company, Waterbury* 20, *Conn.*

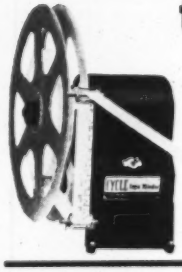
For more information circle **291** on inquiry card.

INSTRUMENT RECTIFIERS

A new CB1A4F and CX5A4F Series of miniaturized copper rectifiers, believed to be the smallest available, feature negligible error with temperature variations, long life, moisture and fungus resistance, retention of electrical characteristics under vibration and high resistance to momentary overload; also meet specs for VU meters. Over-all dimensions of unmounted units ¼" x $\frac{3}{16}$" x 5/32".—*Bradley Laboratories, New Haven, Conn.*

For more information circle **292** on inquiry card.

automation comes to tape-winding



A better method . . . a better machine . . . for automatically winding perforated, communications, computing or accounting tape.

The Cycle Universal Tape Minder is made to satisfy all the demands of modern tape handling techniques. Power driven, static-free, service-free, intermittent winding for any tape minding chore. Tape-minder installations reduce operating costs. The first cost does the job.

Write for descriptive literature, form # IA-11

CYCLE EQUIPMENT COMPANY

17480 SHELBURNE WAY • LOS GATOS, CALIFORNIA #IA-11

For more information circle **98** on inquiry card.

THE OFFNER TYPE 190

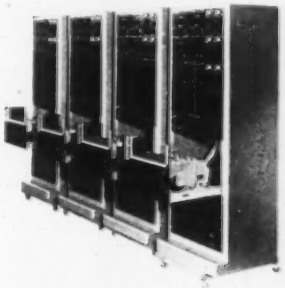
DIFFERENTIAL DATA AMPLIFIER

For amplification of thermocouple, strain gage, and similar low level signals the Type 190 Data Amplifier provides a combination of features available in no other amplifier:

- ☆ **Infinite rejection of common-mode d-c signals**
- ☆ **One microvolt input resolution**
- ☆ **Gain stability of 0.01%**
- ☆ **Rapid step input response**
- ☆ **Linearity of 0.05%**

Ask for bulletin No. 572 giving full technical information

OFFNER DYNOGRAPH
Direct-Writing Oscillograph



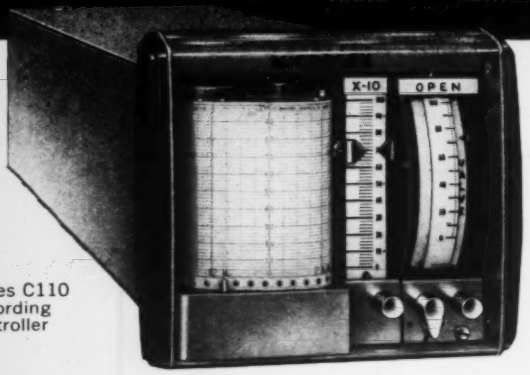
Zero-drift d-c recorder with microvolt sensitivity. One amplifier type covers all requirements.
Models for one to 19 channels.
Rectilinear or curvelinear recording.

Ask for bulletin No. L-861

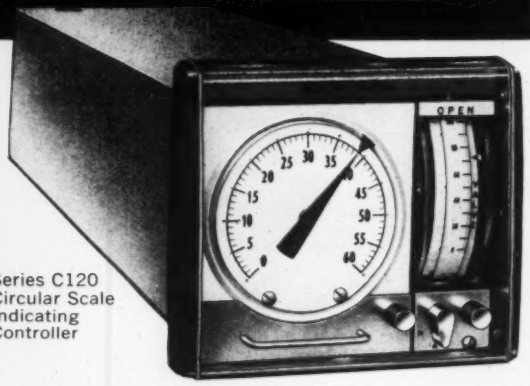
OFFNER ELECTRONICS
5326 N. Kedzie Avenue
Chicago 25, U.S.A.

For more information circle **99** on inquiry card.

NEW TRANSISTORIZED ELECTRONIC CONTROLLERS Interchangeable for complete versatility



Series C110
Recording
Controller



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DC signals of 1.0 to 5.0 milliamperes for instantaneous distance transmission up to 30 miles.

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MANNING, MAXWELL & MOORE, INC.

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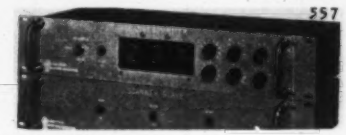

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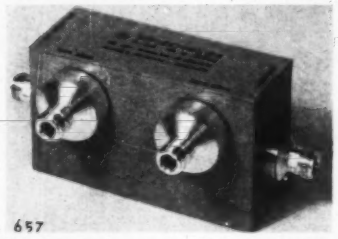

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automation comes to tape-winding

A better method . . . a better machine . . . for automatically winding perforated, communications, computing or accounting tape.

The Cycle Universal Tape Minder is made to satisfy all the demands of modern tape handling techniques. Power driven, static-free, service-free, intermittent winding for any tape minding chore. Tape-minder installations reduce operating costs. The first cost does the job.

Write for descriptive literature, form # IA-11

CYCLE EQUIPMENT COMPANY

17480 SHELBURNE WAY • LOS GATOS, CALIFORNIA #IA-11

For more information circle **98** on inquiry card.

THE OFFNER TYPE 190

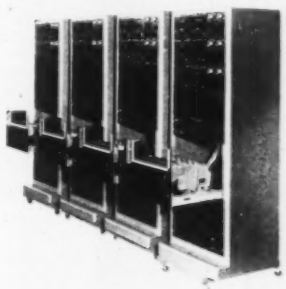
DIFFERENTIAL DATA AMPLIFIER

For amplification of thermocouple, strain gage, and similar low level signals the Type 190 Data Amplifier provides a combination of features available in no other amplifier:

- ☆ **Infinite rejection of common-mode d-c signals**
- ☆ **One microvolt input resolution**
- ☆ **Gain stability of 0.01%**
- ☆ **Rapid step input response**
- ☆ **Linearity of 0.05%**

Ask for bulletin No. 572 giving full technical information

OFFNER DYNOGRAPH Direct-Writing Oscillograph



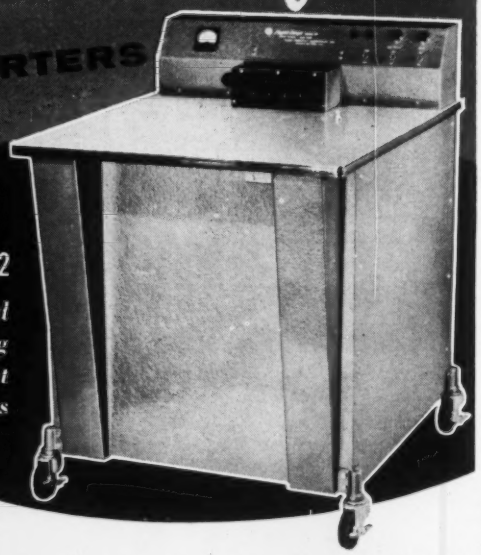
Zero-drift d-c recorder with microvolt sensitivity. One amplifier type covers all requirements.
Models for one to 19 channels.
Rectilinear or curvelinear recording.

Ask for bulletin No. L-861

OFFNER ELECTRONICS
5326 N. Kedzie Avenue
Chicago 25, U.S.A.

For more information circle **99** on inquiry card.

from
Magnet Charger
HEADQUARTERS

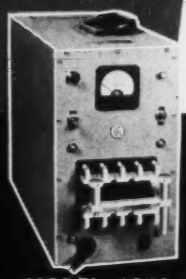


MODEL 942
Recommended by Leading Magnet Makers

3 VERSATILE MODELS

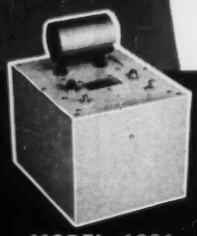
For saturating Alnico magnets weighing up to 34 lbs. and high flux ceramic magnets of any shape or pole configuration. Operates on condenser discharge principle from regular 115-volt, 60-cycle line.

Charging outputs from 100,000 to 200,000 ampere-turns through plug-in transformers, up to 3600 watt-seconds using wire-wound fixtures. Adapters for multi-pole rotors, rod, bar, ring and various other shapes available. Designed for continuous production use with low power consumption. Price of basic unit is less than $2100.



MODEL 107A

A basic condenser discharge unit for most medium size magnets, the Model 107A provides ranges of 12,000 and 24,000 ampere-turns. It is capable of saturating most instrument magnets, including the new core type mechanisms, using adapters or wire-wound fixtures. Designed for continuous duty. Operates from 115-volt, 60-cycle line. Price $530.



MODEL 1221

A low cost, condenser discharge unit employing novel, plug-in wire-wound type charging fixtures, the Model 1221 is designed for the user of small magnets. Its 10,000 ampere-turn output will saturate about 2" of Alnico V. Charging cycle rate is approximately 3 seconds, continuous duty, operates from 115-volt line. Price $180.

Performance of all models is rigidly guaranteed. Prices are net f.o.b. Boonton, N.J. and subject to change without notice.

WE CAN HELP YOU

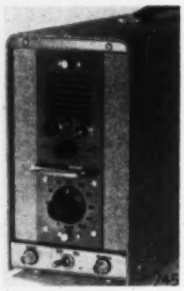
12 years' magnet charging experience is yours for the asking—send for illustrated data sheets.

RFL Radio Frequency LABORATORIES, INC.
Boonton, New Jersey, U.S.A.

For more information circle **100** on inquiry card.

AMPLIFIERS

MEASUREMENT AMPLIFIERS

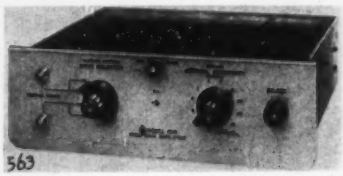


New Model 111-BF wideband dc amplifiers utilize maker's unique chopper circuit to provide extremely stable and accurate amplification of microvolt-level signals from strain gages, thermocouples, etc., used to measure dynamic phenomena; can be used to drive recorders, wideband 'scopes, process control elements, computers, etc.—*Kin Tel*, 5725 *Kearny Villa Road, San Diego* 12, *Calif.*

For more information circle **293** on inquiry card.

PLUG-IN AMPLIFIER

New Model 151A single-channel high-sensitivity plug-in vertical amplifier for Model 150A 10-Mc 'scope

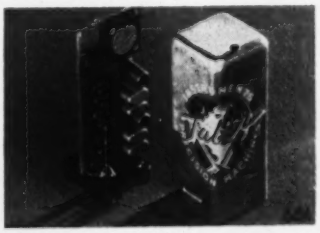


has an input sensitivity of 5 mv/cm from dc to 10 Mc and features exceptionally low drift: after ½ hour warmup, trace drift is less than 0.17 mm/min. Input sensitivity is selectable from 5 mv/cm to 20 v/cm. Vernier adjusts sensitivity smoothly between steps of sensitivity switch and extends sensitivity to about 50 v/cm.—*Hewlett-Packard Co.*, 275 *Page Mill Rd., Palo Alto, Calif.*

For more information circle **294** on inquiry card.

TRANSISTOR AMPLIFIER

New Model 198 amplifier, said to be "the only comercially available transistor amplifier with a 1% closed-



loop gain stability from minus 60°C to 125°C," is a high-gain low-power plug-in amplifier designed for servo and audio applications. Open loop gain 90 db; closed-loop gain variable from 2 to 1000; bandwidth 5 cps to 50 kc. Weight less than 2 oz.—*Section 75, Taber Instrument Corp., North Tonawanda, N. Y.*

For more information circle **295** on inquiry card.

THERMISTOR DEVICES GIVE 1 TO 100 POINT TEMPERATURE CONTROL

Fenwal Units' Accuracy is .25% of Scale

ASHLAND, MASS. — Fenwal engineers here have designed a new Controller using a thermistor and a simple electronic circuit, and the result is a temperature-control system versatile and accurate to within .25% of scale.

The thermistor principle is this: the electrical resistance of the sensing element decreases as its temperature rises. The resistance changes for very small temperature changes are large, making extremely accurate temperature measurement possible.

In the Fenwal system, the thermistor, with its amazing sensitivity and fast responses, feeds an electronic bridge circuit that uses standard tubes. The small thermistor probe, available in several styles, is mounted at the point you wish controlled.

You can mount the compact Unit Controller up to 200 feet away from the control point without losing sensitivity. You can connect it with ordinary lamp cord.

Tailor-Made Designs

But possibly the biggest news in the design is the way the Unit Controllers can be assembled with a common power supply, like building blocks, to provide you with a central system serving up to 100 control points.

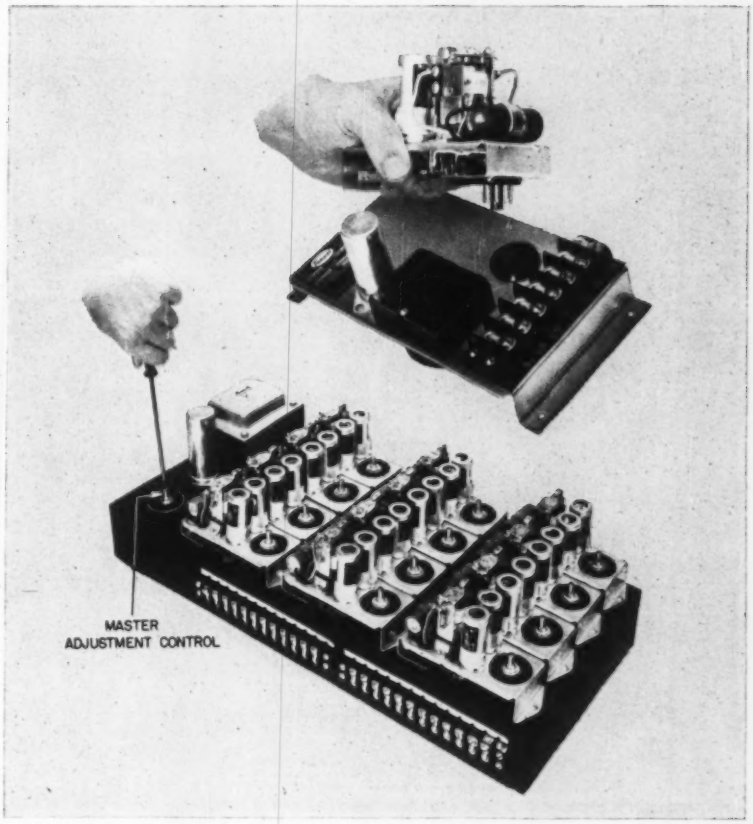
The units are, of course, ideal for use singly as well — each unit serving a single control point, each unit with its own power supply.

The many possible combinations of units are known collectively as the Fenwal Series 53000. There are four standard temperature ranges for you to choose from: −100°F to 50°F; 0°F to 150°F; 100°F to 300°F; and 200°F to 600°F. Special ranges can, of course, be supplied in most cases.

Each Controller includes a potentiometer for temperature adjustment, which you can locate remotely, if you wish. For multiple units, you can have a single master control. This control will let you adjust a complete system, while permitting compensating adjustment for each individual Controller, too.

These Thermistor Controllers are already serving hundreds of companies in many industries. Why not yours? You'll be surprised how inexpensive good control can be.

Designers and process engineers — you will want to have details on this new advance in precision temperature control at your fingertips. Write for information on the Series 53000 Unit Thermistor Controllers to **Fenwal Incorporated, 3611 Pleasant Street, Ashland, Mass.**



FENWAL'S SERIES 53000 UNIT THERMISTOR CONTROLLER — Serves a single temperature control point, but can be combined easily with others, like building blocks, to make up a central system serving up to 100 control points with a single master control if desired. You should know about this. Write Fenwal for details.

Fenwal

CONTROLS TEMPERATURE
. . . PRECISELY

For more information circle **101** on inquiry card.

ONE MAN, and a "Varec" PULSE CODE System, can gauge and record 100 tanks in 12.3 minutes—AUTOMATICALLY

Quite a job for one man—and quite a saving for his employer. A saving in labor, time and overflow losses, and an increase in production efficiency. The secret, of course, is the "Varec" PULSE CODE equipment wisely specified by the farm operator. He has discovered what thousands of successfully operating "Varec" installations have been proving for years: that automation *means* reduced operating costs, and automation by "Varec" *guarantees* it.

"Varec" has been the leader in the field of automatic tank gauging since its inception. This progressive leadership, coupled with over 30 years experience in faithfully supplying the nation's petro-chemical industry with products noted for their dependability and excellence of design and manufacture, has resulted in the "Varec" PULSE CODE Telemetering System—the finest in the field.

"Varec" PULSE CODE reads SAFE—if a pulse is lost or gained you get no reading, not an incorrect reading. "Varec" PULSE CODE can give you an accurate, dependable telemetering system—over unlimited distance using any type single communication channel—for remote gauging of liquid level, temperature reading, and remote control of valves and pumps. It can provide an automatically printed record through an electric typewriter or tape printer. It does the work formerly requiring many field men, infinitely more accurately, and has an amazingly fast pay-out.

Investigate the opportunities of a "Varec" installation for your tank batteries. Competitively priced in initial cost, unmatched in record of performance, when you specify "Varec," you are buying the best.

Send for our free booklet, "A Comparison of Telemetering Systems" and Bulletin CP-3012 on PULSE CODE Telemetering.

THE VAPOR RECOVERY SYSTEMS COMPANY

"Varec"

Compton, California, U.S.A.
Cable Address:
VAREC COMPTON CALIF. (U.S.A.) All Codes

For more information circle **102** on inquiry card.

POWER SUPPLIES

STABLE DC SUPPLY

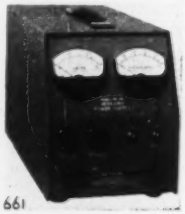
New Model 683 ultra-stable dc power supply unit is for precision scintillation counting and similar ap-

682

plications. Output voltage 100 to 1400 (pos or neg); drift over a 6-day period less than one part in 1000.—*The Victoreen Instrument Co.*, 5806 *Hough Ave., Cleveland 3, Ohio.*

For more information circle **296** on inquiry card.

PORTABLE DC SUPPLY



661

New Models PR 100 and PR 200 deliver 1-100 ma and 0-200 ma respectively. Input 105-125 vac; output 120-300 vdc and 6.3 vac. Regulation is 0.1% for 105-125 vac line and 0.1% for no-load to full-load. Ripple less than 10 mv.—*Nutron Mfg. Co.*, 67 *Monroe Ave., Staten Island* 1, *N. Y.*

For more information circle **297** on inquiry card.

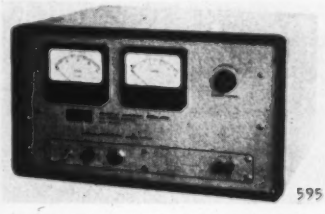
RECTIFIER TYPE SUPPLY

New Model S125-200 25-kw heavy-duty silicon type rectifier power supply has dc output of 125 v nominal at 200 amp (or 250 v nominal at 100 amp). Over-all dimensions 28"W x 24"D x 58"H. Furnished in a floor-standing cabinet.—*Perkin Engineering Corp.*, 345 *Kansas St., El Segundo, Calif.*

For more information circle **298** on inquiry card.

5-AMP DC POWER SUPPLY

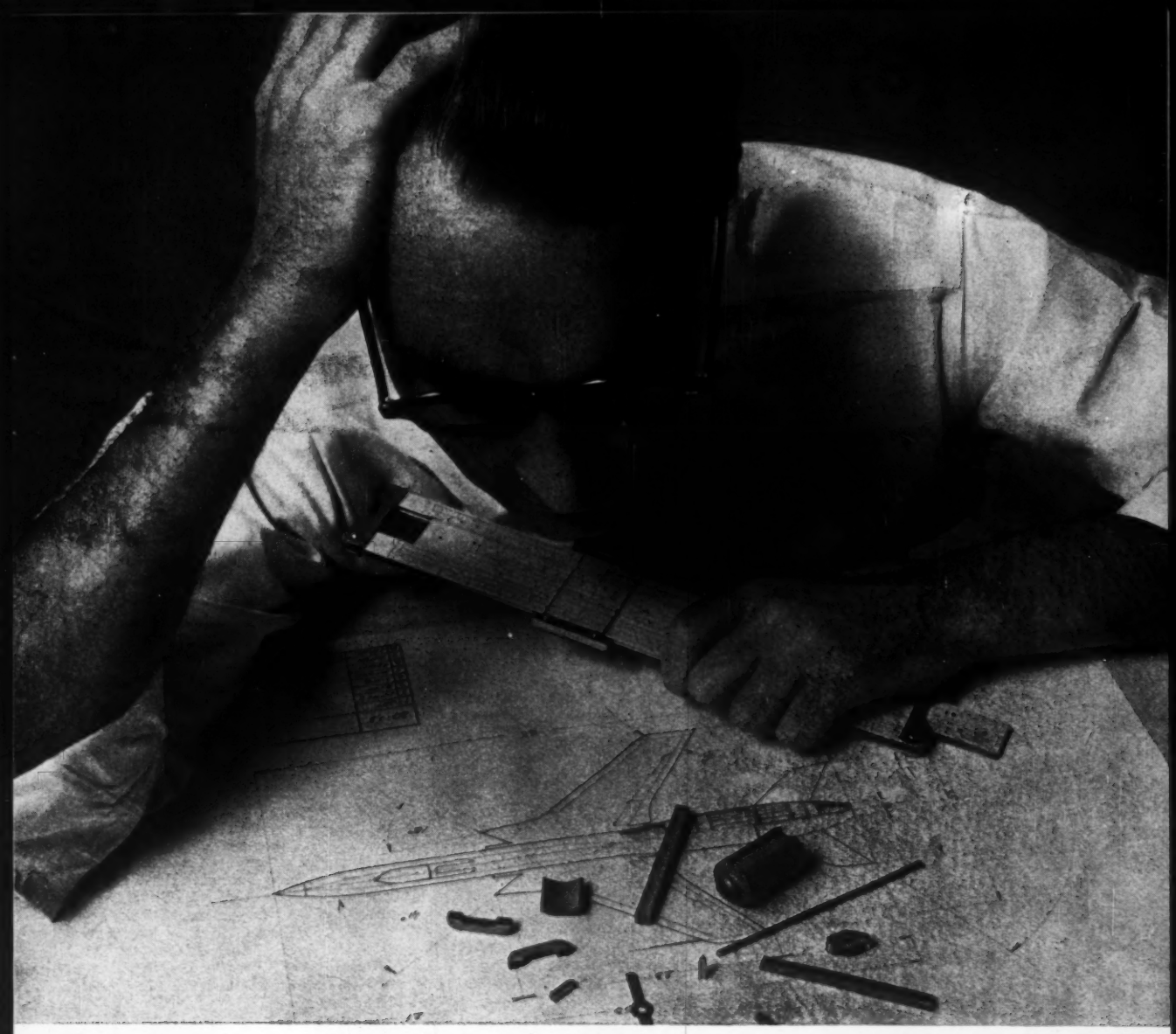
New precision type transistor-magnetic-amplifier-regulated 0-60-vdc 5-amp power supply features 5 mv



595

static regulation; less than 5 mv dynamic line reg; load regulation less than 25 mv static and dynamic combined.—*Perkin Engineering Corp.*, 345 *Kansas St., El Segundo, Calif.*

For more information circle **299** on inquiry card.



Can a 30% increase in magnet energy simplify your design problem?

It probably can if you're faced with the tight space problems involved in today's control and navigation instrumentation, communication, auxiliary power and radar equipment designs.

Only Crucible investment-cast Alnico permanent magnets offer the higher energy you need – 30% more than sintered magnets, for example, size for size. Crucible increases the energy product even further by adding fractional amounts of silicon and zirconium to the magnet composition. These additions also help provide a fine surface finish that is free of gas pockets and other discontinuities. This uniform surface makes grinding easier and faster.

Why not take advantage of Crucible's facilities and experience in this specialized field? A Crucible magnet engineer can work on your problem now. Just call the Crucible office nearest you.

Crucible, the only producer of higher energy investment-cast Alnico permanent magnets, also offers you sand-cast and shell-molded magnets in any shape, tolerance and finish needed. Sizes range from a fraction of an ounce to several hundred pounds.

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CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

For more information circle **103** on inquiry card.

Another great product of GPL precision!

ii-TV 500

From GPL, developers and manufacturers of the famous "150" the compact closed-circuit TV camera that produces the finest quality pictures . . . from the makers of the "152" Ruggedized the TV camera that withstands shocking vibrations, blows and extremes of temperature...comes the new, versatile *ii-TV* 500...again the finest in its class.

economical – will soon save its cost in many applications

single unit system – with controls right at the camera

add-on feature – a full line of easy-to-add accessories and remote controls

For further information or a demonstration, write Mr. N. M. Marshall,
General Precision Laboratory
INCORPORATED
65 Bedford Road, Pleasantville, N.Y.

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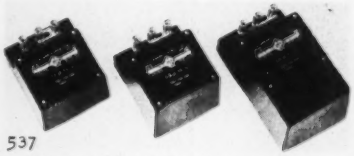
For more information circle **104** on inquiry card.

CAPACITORS

STANDARD CAPACITORS

New Type 1409 Standard Capacitors feature stability, accuracy, low losses, and convenience of use, recent-


537

ly enhanced by use of properly processed silvered mica. Stability: over a three-year period, only random variations in capacitance have occurred with a maximum change of 0.01%. Adjustment accuracy of all models has been improved to 0.1%.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

For more information circle **300** on inquiry card.

HIGH-RELIABILITY CAPACITORS

New B-125 capacitors, designed to withstand mechanical, electrical and thermal abuse, utilize Mylar film for

552

low leakage, and Kraft tissue for exceptional durability. Extended foil construction permits an average current up to 2 amp per uf at all power frequencies (much higher instantaneous values in pulse networks). Units meet proposed high-reliability spec Mil-C-14157A. Capacitance drift between −55°C and 125°C is less than 5%.—*Electron Products Co., 430 N. Halstead Ave., Pasadena, Calif.*

For more information circle **301** on inquiry card.

RESISTORS

ADUSTABLE W-W RESISTOR

New Comp-U-Trim 113, said to be "the only adjustable precision wire wound resistor," is totally encapsu-

723

lated to surpass all applicable MIL specs. It is a precise trimming pot embedded within a precision wire-

Simplify control problems...

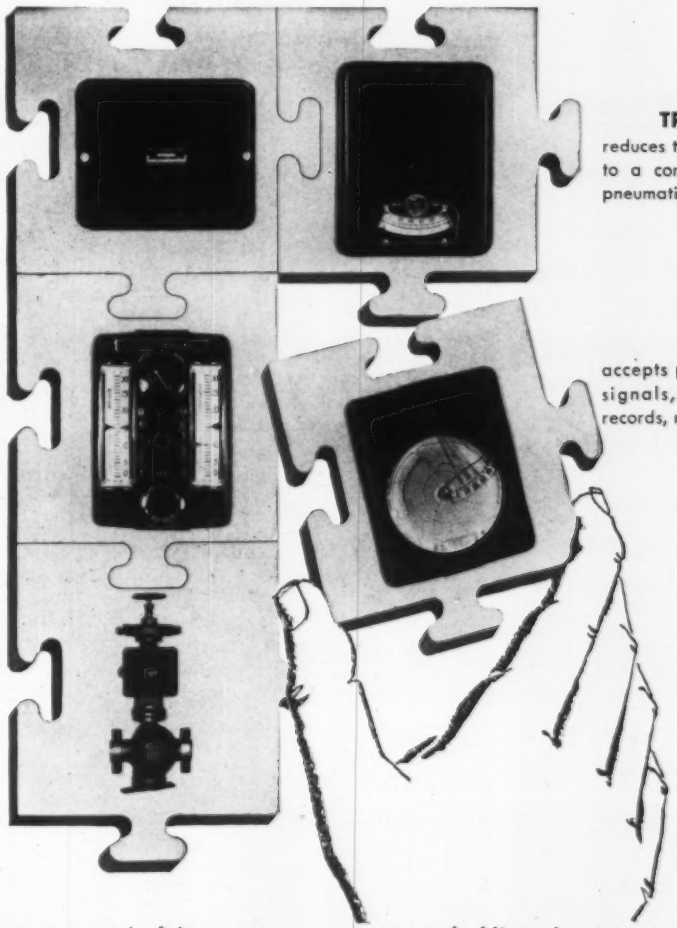
with the Bailey Building Block Method

Control problems are greatly simplified when you attack them using the Bailey Building Block Method. In a nutshell, the method consists of using standard components that fit together like building blocks. Virtually any control requirement can be handled by selecting standard components. Here are the parts you use and the functions they perform.

CONTROL RELAY
takes signals from the transmitter and computes corrective action in terms of pneumatic signals.

SELECTOR STATION
gives operator choice of hand or automatic control including set-point or bias adjustments.

POWER UNIT
Is the "muscle" of the system. It performs whatever precise mechanical action is necessary to achieve control.



TRANSMITTER
reduces the measured variable to a common denominator, a pneumatic or electric signal.

RECEIVER
accepts pneumatic or electric signals, indicates and/or records, measurements.

Not all these components are required in every control system. You buy only what *your* system needs. When you change processes or add more automatic control, you can add additional standard components. Sometimes you may want to build a whole new system, re-using some of the existing components and adding other new ones. Spare parts inventory and maintenance training are reduced.

Hear the complete story of the Bailey Building Block System. Find how it can solve your control problems. See your Bailey Engineer or write for more information. G44-1

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1041 IVANHOE ROAD, CLEVELAND 10, OHIO
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BAILEY BUILDING BLOCK METHOD

RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

BAILEY METERS

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Just one of 10,000 circular and strip recording charts cataloged and quickly available for every instrument in your plant!

P.S. technical will help you design charts for new instruments or special applications

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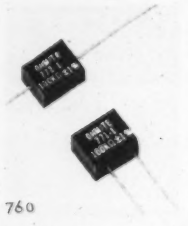
For more information circle **106** on inquiry card.

NEW INSTRUMENTS

wound resistor body, with similar temperature coefficient wire used for both main and trimming sections.—*Eastern Precision Resistor Corp., 675 Barbey St., Brooklyn 7, N. Y.*

For more information circle **302** on inquiry card.

METAL FILM RESISTORS



760

New Series 77 Riteohm precision metal film resistors can be used at full ¼ watt rating in an ambient of 150°C, or up to ½ watt at 105°C or derated to 0 at 190°C. Available values from 100 to 300,000 ohms.—*Ohmite Mfg. Co., 3657 Howard St., Skokie, Ill.*

For more information circle **303** on inquiry card.

ELECTRONIC COMPONENTS

HIGH-POWER DIODE

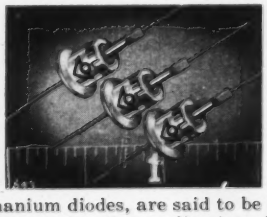
665

New F-7030 high-power high-vacuum diode, for use in charging, shunt or rectifier applications, has a maximum peak inverse voltage rating of 25 kv. Under shunt conditions, maximum peak plate current 75 amp and average plate current 200 ma; in rectifier applications 30 amp max peak and 6 amp max average.—*Components Div., Int'l T&T Corp., 100 Kingsland Rd., Clifton, N. J.*

For more information circle **304** on inquiry card.

SILICON DIODES

New SD 91, 92 and 93 silicon diodes, comparable in cost and electrical ratings to IN91, IN92 and IN93



germanium diodes, are said to be ideal for power supply application. Temperature capabilities to 85°C and lower leakage values are among their advantages over the germanium diodes they supplant.—*International Rectifier Corp., El Segundo, Calif.*

For more information circle **305** on inquiry card.

an ideal result...

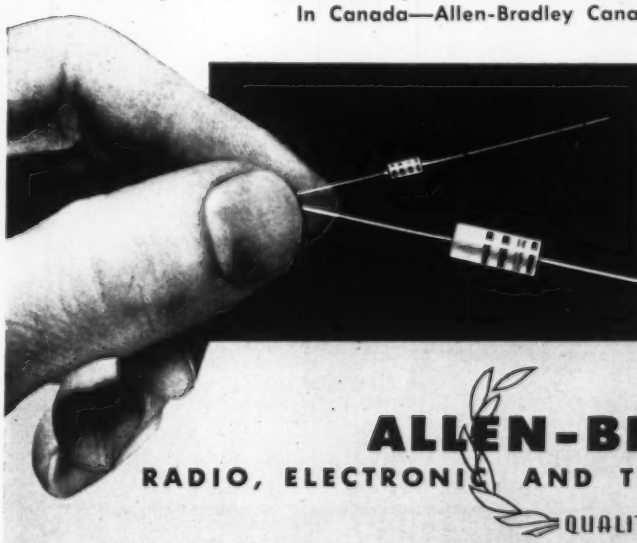
the A-B hot-molded composition resistor... HERMETICALLY SEALED!

● Here's a line of composition resistors that assures you virtually ideal characteristics *plus* complete freedom from catastrophic failures. Because of their ceramic enclosure and high temperature hermetic end seals, these hot-molded composition resistors are unaffected by humidity and moisture. Furthermore, they have an extremely low noise level. All microphonic noise, occasionally encountered in composition resistors due to shock and vibration, has been eliminated. Their unusual rugged construction, and uniformity of size and configuration make these resistors ideal for mechanical handling.

Special techniques have made it practical to increase the operating temperatures beyond the rating heretofore considered "good practice." The Type ES, 1 watt resistor can be operated safely at 165° C without load; the Type TS at 110° C under the same conditions. Available in tolerances of 2% and 5%; in resistance values from 2.7 ohms up.

Write for Technical Data

Allen-Bradley Co., 140 W. Greenfield Ave., Milwaukee 4, Wis.
In Canada—Allen-Bradley Canada Limited, Galt, Ont.



Allen-Bradley Hermetically Sealed, Hot-Molded Composition Resistors, Type TS (1/8 watt) and Type ES (1 watt)

A-B QUALITY

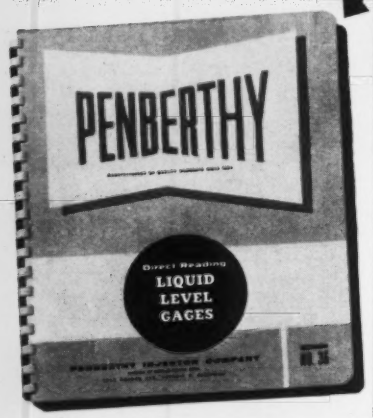
ALLEN-BRADLEY

RADIO, ELECTRONIC AND TELEVISION COMPONENTS

QUALITY

For more information circle **107** on inquiry card.

GET THIS HANDY GUIDE TO BETTER VALVES AND GAGES



Shows complete line of Penberthy valves and liquid-level gages for power, petroleum, and process industries. Includes technical data, parts, price lists, and accessories such as:

HEATING AND COOLING GAGES... for accurate readings where liquids must be cooled or heated to obtain exact measurement.

INSTRUMENT VALVE... permits gage repair or replacement without shutdowns. Back-seating stem permits repacking under pressure.

FROST PREVENTIVE GAGE... eliminates frost build-up... assures dependable visibility. For industries where frosting interferes with accurate readings.

ILLUMINATORS... plastic wedge distributes bright, even light along entire column. Nonglaring... dustproof for perfect illumination.

WELDING PAD GAGES... where process conditions require observation windows as integral part of vessel.

PENBERTHY

Dept. A.

Penberthy Manufacturing Company
Division of Buffalo-Eclipse Corporation
1242 Holden Ave., Detroit 2, Mich.
Please send FREE copy of Catalog #36.

NAME_____ TITLE_____

ADDRESS_____

COMPANY_____

For more information circle **108** on inquiry card.

NEW INSTRUMENTS

PULSE TRANSFORMER

New encapsulated transformer for etched circuitry is keyed for automation; has leads spaced on a 0.1" grid and mounting surface provided with four feet to eliminate moisture trap between unit and etched board. Available in 2 and 3 windings with pulse widths from 0.1 to 16 usec.—*PCA Electronics Inc.*, 16799 *Schoenborn St., Sepulveda, Calif.*

For more information circle **306** on inquiry card.

HALF-WAVE RECTIFIER TUBE

New improved version of 1B3GT, featuring unique hooked filament coil, combines longer life with higher and more stable emission characteristics than other designs.—*Sylvania Electric Products Inc.*, 1740 *Broadway, New York* 19, *N. Y.*

For more information circle **307** on inquiry card.

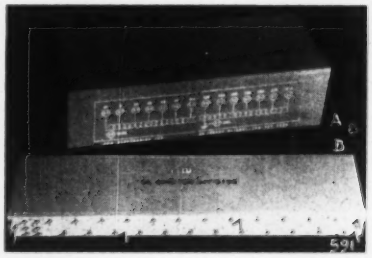
HIGH-POWER TRANSISTORS

Four new germanium transistors: DT-100, said to be "the highest rated commercially available," has a collector diode rating of 100 volts with the same high current handling capacity of maker's other transistors. 2N-441, 2N442, and 2N443 are 12-amp 55-watt transistors offering narrow gain limits and with 40- 50- and 60-v collector diode ratings respectively.—*Delco Radio Div., Kokomo, Indiana.*

For more information circle **308** on inquiry card.

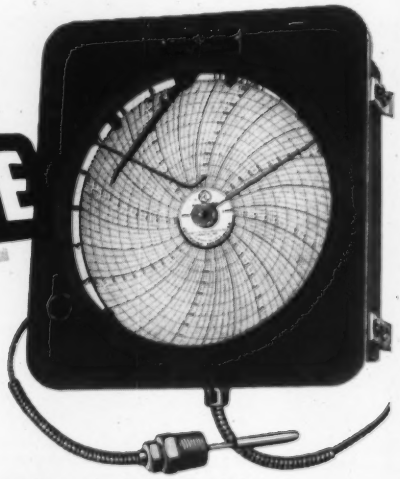
DELAY LINES

Two new highly-miniaturized hermetically-sealed lumped-constant delay lines: (A) DL 1000L-246 12T,



246-usec, risetime only 5 usec; exceptionally low attenuation of 3 db; tapped at 6 usec and every 20 usec thereafter; tolerances of 1 usec; two 8 pin headers but can also be supplied with octal plugs. (B) DL 360L-120, 120 usec with exceptional risetime of 1.4 usec; taps as desired with delay tolerance of 0.25% at taps and

A NEW Development from AUTO-LITE



INKLESS TEMPERATURE RECORDER!

The newest advance in temperature recording . . . Auto-Lite model 2200 operates completely without ink. It simplifies temperature recording for most processing operations.

- 2 small mercury batteries in case energize transistor oscillator connected to stylus arm.
- Stylus records temperature on 6" evenly calibrated sensitized chart.
- Battery life approximates 2000 hours.
- Records operating temperatures for 24-hour or 7-day cycles.
- Easily serviced — minimum maintenance.

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TEMPERATURE RECORDERS & INDICATORS

For more information circle **109** on inquiry card.

output; low attenuation of 3 db; temperature coefficient less than 25 ppm from −40°C to 105°C; pin terminals recessed for plug-in to printed circuit board or conventional hooked terminals.—*PCA Electronics Inc., 16799 Schoenborn St., Sepulveda, Calif.*

For more information circle **309** on inquiry card.

ALL-ELECTRONIC CHOPPER

New miniature No. 333058 (¾" dia × 1-7/16" long) contains no moving parts, has operating life of 5000

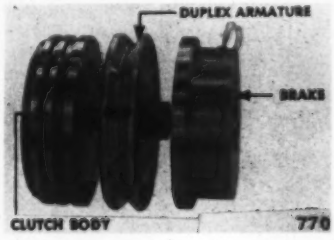
hours. Primarily a dc to ac voltage converter sensitive to phase of reference voltage, it can be used to convert ac into direct voltage. Among features: zero phase shift, 180° dwell time, frequency range 60 cps to 20 kc.—*Kearfott Co., Inc., 1378 Main Ave., Clifton, N. J.*

For more information circle **310** on inquiry card.

ELECTROMECHANICAL COMPONENTS

ELECTRIC CLUTCHES & BRAKES

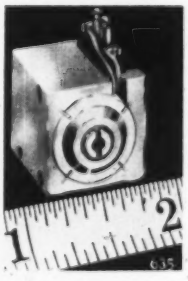
New larger sizes in maker's line of electric clutches and brakes comprise five styles in six sizes from 4"



to 12" dia, with torque outputs from 10 oz-in to about 450 lb-ft. Photo: combination clutch-brake 6½" dia Unit CB 160.—*Simplatrol Products Corp., Worcester, Mass.*

For more information circle **311** on inquiry card.

MIDGET SOLENOID



New linear-stroke solenoid, "believed to be the smallest and lightest of its type," is shock-resistant, meets Air Force environmental requirements for installation in fighter planes; weighs less than

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HARDENING
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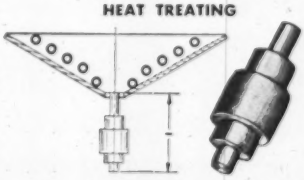
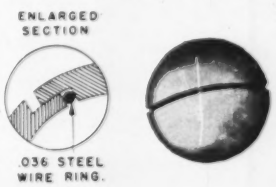
TYPICAL INDUCTION HEATING APPLICATIONS

TEMPERING FOR CUSTOM HEAT TREATING



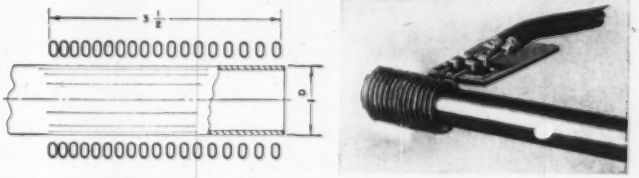
Selected areas of hardened steel parts may be tempered for fabrication or service requirements. Concentrator type coil permits high power density in restricted area thus minimizing heating time and permitting marked variation in properties in adjacent sections.

WIRE RING JOINS PLASTIC PARTS



High frequency induction heats wire ring which in turn heats plastic wall, providing sufficient plasticity to cause flow and bonding upon application of pressure. Metal to plastic seals are similarly performed.

ANNEALING ALUMINUM FURNITURE TUBING



Selective annealing of aluminum furniture tubing permits bending where required without loss of strength in adjacent portions of tube. Brass or steel tubing is also being selectively annealed.

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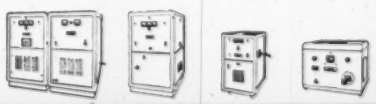

All Lepel equipment is certified to comply with the requirements of the Federal Communications Commission.

LEPEL HIGH FREQUENCY LABORATORIES, INC.
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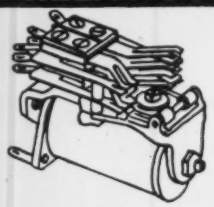
For more information circle **110** on inquiry card.

Universal RELAY CORP.

THE LARGEST STOCK OF RELAYS IN THE WORLD



SMALL TELEPHONE TYPE RELAYS

Similar in design and operation to the longer telephone types but approximately half the size. All connections are at one end. Clare type "J", Automatic Electric type "E", and Phillips 8QA are included in this group. Except for slow acting groups they can be mounted in any position. Coils and frames are standard and interchangeable.

COILS

For Cost of Relay Add Price of Coil to Price of Frame

Stk≠	Ohms	Price Ea*
K801	100	1.25
K802	150	1.25
K803	300	1.25
K804	400	1.25
K805	500	1.25
K806	550	1.50
K807	1300	1.50
K808	2000	2.00
K809	4000	2.25
K810	6500	2.75
K811	20000	4.50
K812	21000	4.50
DUAL COILS		
K813	380 380	2.00
K814	5000 10000	3.75
SLOW MAKE		
Copper Slug at Armature End		
K815	24	2.00
K816	350	2.00
SLOW RELEASE		
Copper Slug at Heel End		
K817	350	2.00

ALL MERCHANDISE IS GUARANTEED AND MAY BE RETURNED FOR FULL CREDIT

Prices listed with asterisk (*) are subject to QUANTITY DISCOUNTS

1-9 ..... as quoted 50-99 ..... 15%
10-49 ..... 10% over 100 ..... 20%

FRAMES

For Cost of Relay Add Price of Frame to Price of Coil

Stk≠	Contacts	Price Ea*
F801	1A	1.45
F802	1A, 1B	1.65
F803	1A, 1C	1.85
F804	1A, 1B, 1C	2.00
F805	1A, 1B, 2C	2.50
F806	2A	1.65
F807	2A, 1B	1.85
F808	2A, 1C	2.00
F809	3A	1.85
F810	3A, 1C	2.25
F811	4A	2.00
F812	4A, 1B	2.25
F813	4A, 2B*	2.50
F814	5A	2.25
F815	6A, 2C	3.50
F816	1C	1.65
F817	2C	2.00
F818	3C	2.50
F819	4C	3.00
F820	5C	3.50
F821	6C*	4.00
F822	Frame+	1.25

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+No Contacts

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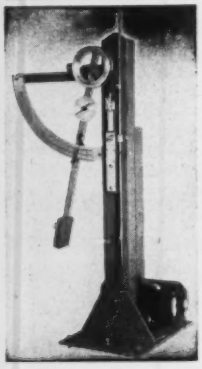

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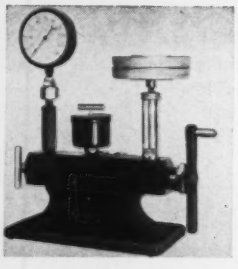

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45-45 Van Sinderen Ave., Brooklyn 7, N. Y.

For more information circle **112** on inquiry card.

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For more information circle **113** on inquiry card.

NEW INSTRUMENTS

1 oz. Operating on 28 v, plunger stroke bridges a gap of 0.08" at 24 v and exerts a minimum pull of 6 oz.—*J. A. Maurer, Inc.*, 37-01 31*st St., Long Island City, N. Y.*

For more information circle **312** on inquiry card.

500°F ROTARY SOLENOID

New model of Ledex Rotary Solenoid withstands 500°F. Moreover, because of its special materials, it can be operated with much higher wattage inputs for producing higher torques; and can be used in radioactive atmospheres without damage.—*G. H. Leland*, 123 *Webster St., Dayton* 2, *Ohio.*

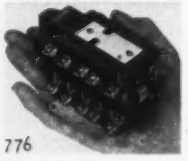
For more information circle **313** on inquiry card.

ROTARY SOLENOIDS

New Ledex Rotary Solenoids with solder terminals offer advantages such as elimination of a secondary terminal normally required with pigtail type leads. Terminals are compression glass insulated to provide high resistance to tensile and impact shocks.—*G. H. Leland, Inc.*, 123 *Webster St., Dayton* 2, *Ohio.*

For more information circle **314** on inquiry card.

TEN-CONTACT RELAY

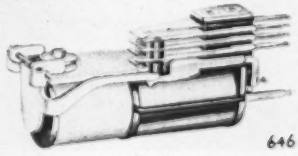


New 10-contact unit is added to maker's Type D 10-amp relays; has a maximum of 6 n-o and 4 n-c or 8 n-o and 2 n-c contacts.—*Square D Co.*, 4041 *N. Richards St., Milwaukee* 12, *Wis.*

For more information circle **315** on inquiry card.

TELEPHONE-TYPE RELAY

New versatile relay, adjusted and tested to strict telephone relay adjustment practices, has contact combina-

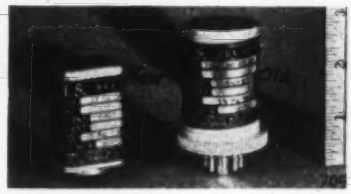


tions up to 10-p° dt. Contacts are rated 3 amp 150 w ac non-inductive load. Unit can be supplied with copper head for delayed attract up to 0.1 second depending upon spring assembly and coil power; copper heel for delayed release up to 0.4 second with small spring assembly and power coil.—*Guardian Electric Mfg. Co.*, 1621 *W. Walnut St., Chicago* 12, *Ill.*

For more information circle **316** on inquiry card.

SENSITIVE CONTROL RELAY

New Model 126 VHS (Very High Sensitivity) Meter-relay embodies recent design changes; is smaller,



more resistant to resonance under vibration, generally more reliable, and easier to put together.—*Assembly Products, Inc., San Gorcinto Div., Desert Hot Springs, Calif.*

For more information circle **317** on inquiry card.

6P DT RELAY

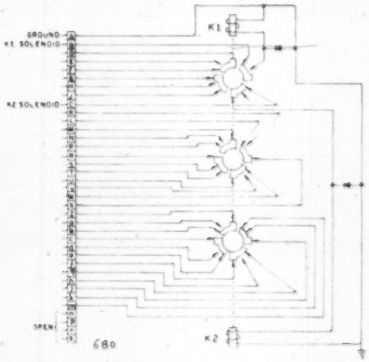
634

New Mark II is based on a novel switching principle intended specifically for extreme environmental and operating conditions: "Wedge action" achieves a positive contact in both energized and de-energized conditions, with constantly-increasing contact pressure during overtravel period after initial engagement; also removes contaminants from contact surfaces, making unit extremely shock- and vibration-resistant. Now available: Mark II 6-pole double-throw miniature hermetically-sealed unit designed to meet or exceed MIL-R-5757C and MIL-R-25018.—*Electro Tec Corp., South Hackensack, N. J.*

For more information circle **318** on inquiry card.

REMOTE SWITCHING DEVICE

New Type SWM-9610-04 10-p dt hermetically-sealed self-stepping remote switching mechanism can elec-



trically open or close (and manually opening); features extremely low contact resistance of 0.1 ohm maximum at 300 ma at about 6 vdc constant throughout life. Minimum life 10,000 positive electrical cycles and 1000

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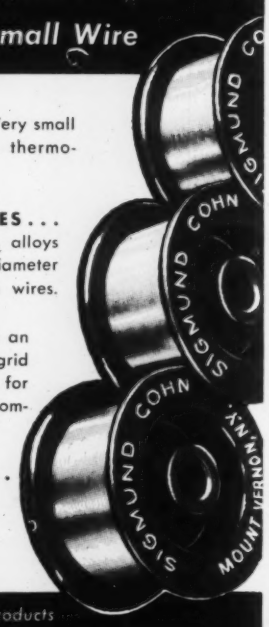

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change resistance in a magnetic field; have thousands of uses for magnetic field and non-contact resistance - type measurements

$7.50 each

Size #1—$1\frac{13}{16}$" x $\frac{7}{8}$" x 0.007
Size #2— $\frac{3}{4}$" x $\frac{1}{4}$" x 0.007

Feature: Copper terminals for soldering leads; mounted on a flexible plastic; easy to install in air gap of magnets for gauss measurements and electronic controls; resistance change follows Smithsonian table values.

Capacity: one milliampere. Size #1 is made in 3000 ohm, 2500 ohm, 2000 ohm, 1500 ohm, and 1000 ohm regular stock; also from 250 ohm to 1950 ohm in odd sizes for experimental values. Size #2 made in 300 ohm, 275 ohm, 250 ohm, 225 ohm, 200 ohm, 175 ohm, and 150 ohm.

Fitzpatrick Electric Supply Co.

444 Irwin St. Muskegon, Mich.

For more information circle **117** on inquiry card.

NEW INSTRUMENTS

positive manual cycles. Contacts can carry 15 amp with make or break capacity of 5 amp 125 v. Switch body case is about 9" long by 3" dia.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.*

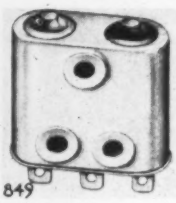
For more information circle **319** on inquiry card.

PUSH BUTTON SWITCH

New Series 34 Silent-Action miniature push button switch for solderless wiring is a non-snap momentary-contact n-o sp-st switch designed with taper pins. Three female receptacles with built-in short between two of them accomodate "in and out" wiring with A-MP No. 53 taper pins.—*Grayhill, Inc., 561 Hillgrove Ave., LaGrange, Ill.*

For more information circle **320** on inquiry card.

SEALED SWITCHES



New miniature precision switches are hermetically sealed, but actuation is not affected by ambient pressures as high as 180 psi, nor by a vacuum, because a balancing system automatically compensates for environmental pressures. Units can be furnished with maximum actuation force of either 10 oz or 32 oz. Various electrical ratings.—*Haydon Switch, Inc., Waterbury 20, Conn.*

For more information circle **321** on inquiry card.

CONNECTORS, etc.

OBLONG CONNECTORS

New oblong connectors with 15 butt-type contacts represent a new concept of lateral action mating whereby interconnecting equipment is fastened via a sliding action; are rated 10 amp per contact at about 500 v. Mated pair measure 3½" long by 1⅓" deep.—*Amphenol Electronics Corp., Chicago 50, Ill.*

For more information circle **322** on inquiry card.

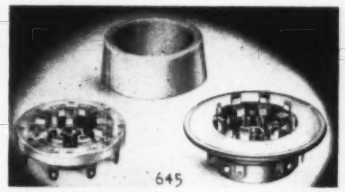
RACK-&-PANEL CONNECTORS

New environmentally sealed rack & panel connectors designed for potting are available with 57 electrical contacts and 2 coaxial connectors or 75 electrical contacts with 3 coaxial connectors. Rating 7.5 amp per contact at 600 vdc. Coaxial connectors have captivated contacts, accommodate RG-58/U or RG-141/U and have a nominal impedance of 50 ohms. Temperature range −65°C to 125°C with appropriate potting compound.—*Amphenol Electronics Corp., Chicago 50, Ill.*

For more information circle **323** on inquiry card.

LOW-COST SOCKET

New low-cost socket for 4X150A, 4X250B and similar tubes requiring forced-air cooling is designed for com-

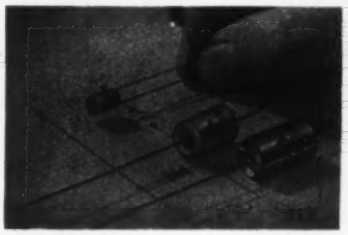


mercial and military application; is available in several versions: with or without integral 2700 uuf screen-grid bypass capacitor, with cathode terminals grounded or ungrounded to shell. A heat-resistant steatite chimney (also available) directs air flow through tube cooling fins.—*E. F. Johnson Co., Waseca, Minn.*

For more information circle **324** on inquiry card.

CONTACT PROTECTORS

New selenium contact protectors for arc suppression are available in three basic configurations: (1) tiny



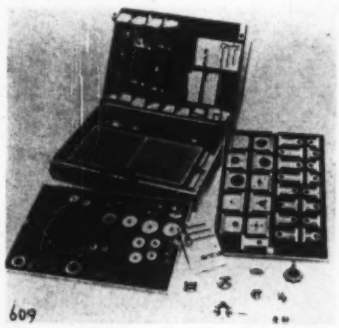
encapsulated diode types, slightly larger than a match head; (2) fibre tube cartridge types; (3) hermetically sealed cartridge types resisting severe environmental conditions.—*International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif.*

For more information circle **325** on inquiry card.

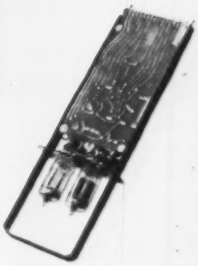
MECHANICAL COMPONENTS

BREADBOARD KIT

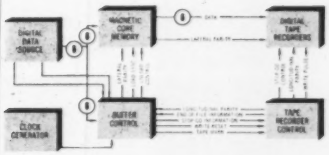
New Type D miniature precision breadboard kit for use in R&D contains over 850 different mechanical



End data format problems with the NEW EECO FORMAT CONTROL BUFFER



. . . Converts input data into compatible format for your individual Data Processing Equipment.



The basic EECO Format Control Buffer accepts digitized data at random rates and produces digital magnetic tapes in the computer Format, suitable for entry into virtually any computer depending on the Format Control Buffer Model. *It can also be furnished to provide for conversion from one computer format to another.* And it can be modified to handle conversion to paper tape, punched cards, or digital plotters.

Input Input can be from such sources as: **Analog-to-digital Converters • Time Registers • Punched Card Readers • Electric Typewriters • Punched Paper Tape • Digital Magnetic Tape**

Source material is presented to the Format Control Buffer as parallel input. Control inputs are normally provided by the data source. And EECO can incorporate a digital multiplexer in the Format Control Buffer to meet your individual requirements for entering data from multiple sources.

Data Input Rate The EECO Format Control Buffer can be set to produce records of any desired length from one to 1024 characters.

Each complete record is read out of the magnetic core memory onto the output magnetic tape at the specified recording density

Maximum **instantaneous** input rate approximately 40,000 characters per second.

Maximum **average** input rate is limited by average output rate, which, in turn, is determined by the digital recorder tape speed and by the number of characters per record.

Output Format Meets all requirements of the computer format, including parity, check, inter-record and end-of-file gaps, and end-of-file characters or gap.

Construction EECO Computer-Series plug-ins are used extensively These incorporate specially designed, ultra-conservative circuits to ensure greatest possible reliability

Full details on the new EECO Format Control Buffer are contained in Bulletin FC-234. Send for your copy today and learn how you can increase the scope of your Data Processing Equipment.

ELECTRONIC ENGINEERS AND PHYSICISTS

EECO offers unusual career opportunities in the creative field of systems and related electronic projects. Send resume of your qualifications to the attention of R. F. Lander.

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For more information circle **118** on inquiry card.

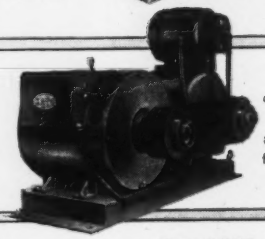
KATO VARIABLE FREQUENCY
MOTOR GENERATOR SETS
For Better Bench Mock-Up Tests!

VARIABLE FREQUENCY MOTOR GENERATOR SETS adjust 360 to 440 CPS. Generator mounted controls include reset buttons, limit switch. Motor and generator remain stationary. Vari-drive pulley adjustment is controlled by small motor.

CONTROL PANELS
Synchronous motor starter and generator controls including magnetic amplifier voltage regulator in cabinet.

REMOTE CONTROL
Remote control frequency adjustment varies speed from 1080 to 1320 rpm., thus varying frequency. Bench Mock-Up Test Station may be located anywhere.

MANUAL ADJUSTED MODELS
Continuously adjustable, holds speed accurately. Simple hand wheel controls variable-pitch V-belt arrangement permitting the often desired frequencies of 36, 40, 50, 60 and 70 cycles per second. Output indicated by frequency meter. Single, 3 phase or D. C. drive motors available. Also other frequency ranges.



Also 40 CYCLE A.C. GENERATORS from 350 watts to 500 KVA.

Builders of Fine Electrical Machinery Since 1928
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WRITE TODAY FOR FOLDER!
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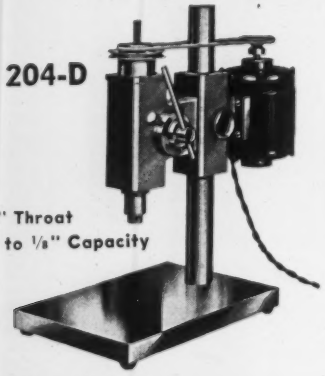
For more information circle **119** on inquiry card.

Precision drilling made easy!

The *Phillips & Hiss*

204-D



6" Throat
0 to 1/8" Capacity

Sensitive "Feel"

Sensitive Speed Control: Foot operated, leaves both hands free.

High Precision: Spindle true within .0002". Table square .0001" per inch. Accuracy permanent, castings annealed and ground.

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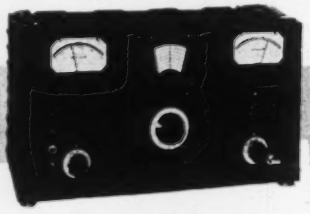
For more information circle **120** on inquiry card.



MODEL 65-B

STANDARD SIGNAL GENERATOR

75 Kc to 30 Mc

Provides test signals for the measurement of the sensitivity, selectivity, overload, distortion, noise and stage gain characteristics. It meets the exacting requirements for laboratory use and production testing.

Write for Bulletin 156

Laboratory Standards
MEASUREMENTS CORPORATION
BOONTON, NEW JERSEY

For more information circle **121** on inquiry card.

NEW INSTRUMENTS

components; enables use of 1/8" bore gears of 96 pitch.—*PIC Design Corp., 477 Atlantic Ave., East Rockaway, N. Y.*

For more information circle **326** on inquiry card.

SEALING RING

New "Wingseal" synthetic rubber sealing ring is offered for interchangeable use with AN6290 o-ring sizes on AND 10056 fittings in AND 10050 boss; has passed a two-part test, one using maximum seals in minimum bosses and the other minimum seals in maximum bosses. Sizes from 2 through 32 (used with fittings for tubing from 1/8" through 2" OD).—*Rubber Products Div., Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.*

For more information circle **327** on inquiry card.

TUBING TROUGH CLAMP

New cushion clamp secures instrument tubing to tubing support when particular care must be used to minimize vibration. It comprises two pieces of sponge neoprene with nitrogen-filled voids to prevent moisture absorption. Two wing nuts draw clamp tight in place over pieces of tubing.—*T. J. Cope Div., Rome Cable Corp., Collegeville, Penna.*

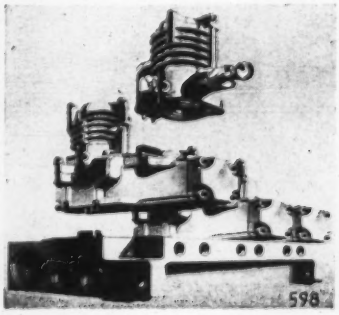
719

For more information circle **328** on inquiry card.

VALVES

4-WAY VALVES

New Speed King plug-in type 1/4" 4-way control valves are fitted with built-in plugs and connectors which complete electrical connections automatically; are available in single- and double-solenoid types, for manifold or sub-base mounting; minimize

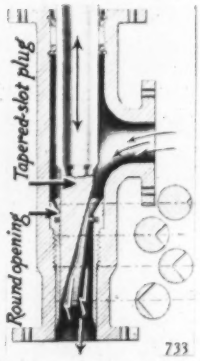


598

original installation and in-service maintenance time. Service life is said to exceed 25 million cycles. Valves for 30-250 psi air service are available with solenoid coils for ac or dc, any voltage. Manifolds can be ganged for multiple installation of any number of valves.—*Valvair Corp., 454 Morgan Ave., Akron Ohio.*

For more information circle **329** on inquiry card.

TAPERED-ORIFICE VALVE

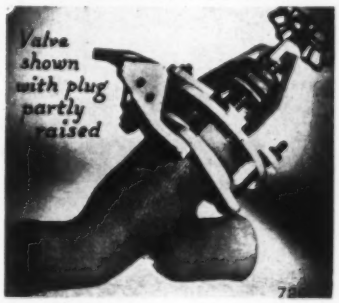


New Tapered Orifice Valve utilizes a plug with a tapered slot, moving into and out of a circular opening, thereby varying area at head of opening. A circular sealing ring eliminates bypass. New valve will pass foreign particles up to twenty times larger than would comparable needle valves. Other advantages: infinitely-variable control; non-clogging; non-freezing; abrasion-resistant; excellent coefficient of flow at all settings with low turbulence. Available in many sizes, pressure ranges and connections.—*General-American Valve Co., P. O. Box 444, Corona Del Mar, Calif.*

For more information circle **330** on inquiry card.

GLASS Y-TYPE VALVE

New Y-type 2" valve is made of tempered Pyrex brand borosilicate glass; all working parts exposed to



fluid are of glass or Teflon. Will fit into any system of process piping where valve corrosion and erosion are problems. Allowable sudden temperature differential through valve is 200 F°; maximum line pressure at valve is 50 psig. Weighing 9 lb (incl mounting bracket), it is ⅓ to ¼ the weight of conventional 2" valves.—*Corning Glass Works, Corning, N. Y.*

For more information circle **331** on inquiry card.

OXYGEN VALVE

New Oxygen Cylinder Valve is so designed that, when operated by hand, at maximum rate, there will

Giannini
ROTOSTEPPER

Pulse-to-shaft Position Converter

Powerful, rapid, absolutely controllable shaft rotation in precise 2° increments... for DC pulse-to-analog shaft positioning in computers, sequence switching, algebraic counting, remote shaft positioning.

Pulsed DC from hand operated switches, choppers, or any similar manual or automatic pulsing devices controls the Giannini Rotostepper in precise 2° angles of rotation .... unlimited in either direction, at the rate of one step per pulse.

Optional control mechanisms available on the versatile Rotostepper provide homing to a fixed reference angle, automatic continuous stepping with a steady DC voltage, and/or potentiometric divided voltage functional to shaft position.

SPECIFICATIONS:

TORQUE:	Up to 14 oz-in
SPEED:	Up to 60 steps per second
ROTATION:	Unlimited CW or CCW in 2° increments
LOCK:	Spring detent locks shaft in a position accurate to ±6′
INPUT:	28 volts DC, 10 milliseconds minimum duration per step

Giannini

PRECISION INSTRUMENTS & CONTROLS

For further information write for Rotostepper Bulletin 8915

G. M. GIANNINI & CO., INC., 918 E. GREEN ST., PASADENA, CALIF.

For more information circle **122** on inquiry card.

WesCo has hundreds of Aircraft and Industrial solenoids

Look to **WesCo** engineers with your aircraft or industrial solenoid problem. Hundreds of proven designs available. **WesCo** will modify or furnish special designs to fit your specifications.

Here are some of the features available:
High temp units tested past 600°F. • Adjustable plunger travel • Plunger cavity pressure sealed • Push or pull types 12 to 115 volts • Miniature, medium and heavy duty types • 400 cycle AC units also available.

Remember, when you need a solenoid, think of **WesCo AC INDUSTRIAL SOLENOIDS**—full line. Write for brochure. **DC AIRCRAFT SOLENOIDS**—send specifications, or write for catalog.

The trademark on millions of solenoids since 1927

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For more information circle **123** on inquiry card.

HARDNESS TESTING

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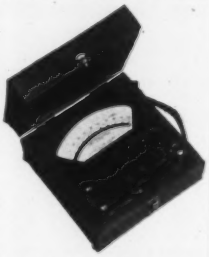
For more information circle **124** on inquiry card.

RAWSON THERMOCOUPLE METERS



R.M.S. Readings No Wave Form Errors

SINGLE RANGES from 1 ma full scale to 10 amperes full scale. Good from DC to 2 megacycles and higher.

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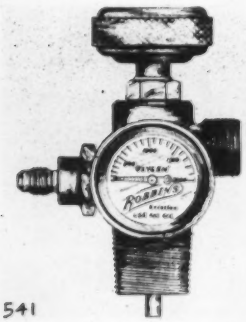
112 Potter Street Cambridge, Mass

For more information circle **125** on inquiry card.

NEW INSTRUMENTS



541

be no instanteous pressure surge downstream; valve will open smoothly without undue cracking torque.—*Robbins Aviation, 1735 W. Florence Ave., Los Angeles 47, Calif.*

For more information circle **332** on inquiry card.

6000-PSI CONTROL VALVES

771

New line of 6,000-PSI 2- and 3-way control valves for use on equipment requiring extremely high operating pressures ranges from ½" to 2"; features shockless opening and closing at maximum rated pressure, bodies machined from aluminum-bronze bar stock, replaceable hardened stainless steel seat sleeve inserts in valve bodies. Valve diaphragm is actuated by 35- to 40-psi air.—*Sinclair-Collins Valve Co., 454 Morgan Ave., Akron 11, Ohio.*

For more information circle **333** on inquiry card.

ALL-PLASTIC VALVE

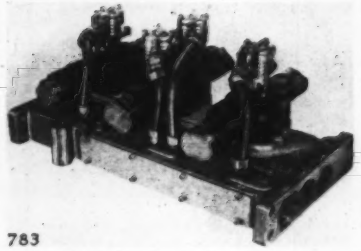
897

New SV-5100 Series all-plastic solenoid valves will handle caustics, acids, and highly corrosive media. Bubble-tight seal, said to be "of revolutionary construction," gives valves unusually long life under extreme conditions. Operate in any position, on 115 v 60 cps, also available in dc.—*Valco Engineering Corp., Carnegie Ave., Kenilworth, N. J.*

For more information circle **334** on inquiry card.

VALVE MANIFOLD

New high-capacity multiple-station manifold provides compact economical group mounting of basic ¾" Speed King 2-, 3- and 4-way pilot-operated control valves; is offered in 2- and 3-



783

station types, has full-length inlet and exhaust ports common to all valve stations and full-length conduit passage for wiring with removable cover for easy access to connections. —*Valvair Corp., 454 Morgan Ave., Akron 11, Ohio.*

For more information circle **335** on inquiry card.

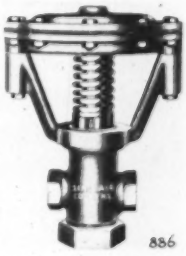
SOLENOID VALVES

853

New low-cost Series J solenoid valves for general industrial applications utilize principle of pilot port operation; are designed for control of non-corrosive fluids with maximum operating pressure differential of 150 psi; can be mounted in any position.—*Controls Div., Jackes-Evans Mfg. Co., 4427 Geraldine Ave., St. Louis 15, Mo.*

For more information circle **336** on inquiry card.

IRON BODY VALVES



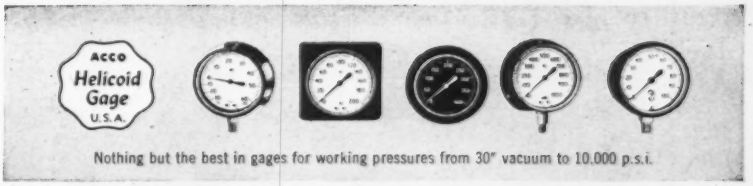
886

New diaphragm-operated control valves with ductile iron bodies, for control of rubber molding and similar equipment, are suitable for hot water service at pressures to 600 psi and temperatures to 350°F, in 2-way, 3-way n-o or n-c and reverse acting types, from ½" to 1½" NPT. —*Sinclair-Collins Valve Co., 454 Morgan Ave., Akron 11, Ohio.*

For more information circle **337** on inquiry card.

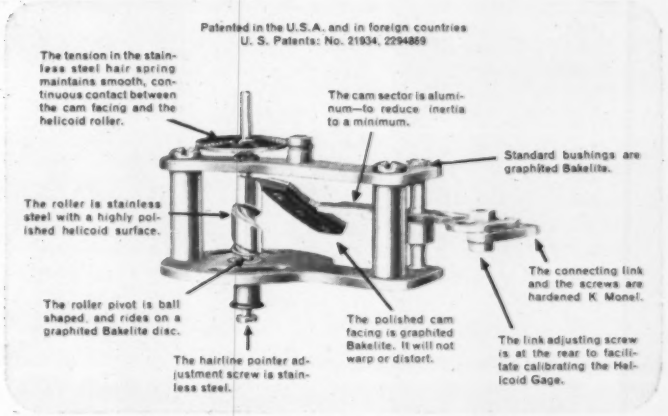
PILOT-OPERATED VALVES

New line of 2-way universal pilot-operated valves in pipe sizes from 1½" through 3", n-o or n-c, can be used with air, oil, water or vacuum, for pressures to 500 psi. Remote control operation utilizes fluid principle of balanced and unbalanced flow line pressure. When pilot pressure and line pres-



Nothing but the best in gages for working pressures from 30" vacuum to 10,000 p.s.i.

These details of Helicoid gage design assure longer life and enduring accuracy


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown above. Such Helicoid features—protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation.

Easiest adjustment and calibration

Only Helicoid Gages have the external pointer adjustment pictured here. The Helicoid type adjustment cannot be jarred out of position.

Calibration of Helicoid Gages is accomplished easily, without removing dial or pointer, because the link adjusting screw is at the rear of the system.

Tubes built for millions of pressure pulsations

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials —alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak or crack.

For complete information on the Helicoid line of gages write for **Catalog G-52**

Helicoid gives you all these features at prices that are competitive in the quality gage field.

Helicoid Gage Division
AMERICAN CHAIN & CABLE

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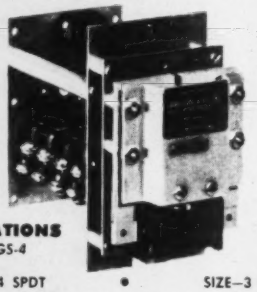
ACCO TRADE MARK

For more information circle **126** on inquiry card.

HIGH ALTITUDE
BALLOON
CONTROL INSTRUMENTS
require MAXIMUM Performance
MINIMUM Size - Weight - Power Drain

BRAILSFORD AGS TIMERS ARE UNMATCHED IN THESE BASIC REQUIREMENTS



IF YOU HAVE A TIMING PROBLEM WHERE SIZE, MASS AND POWER DRAIN ARE CRITICAL READ THESE

SPECIFICATIONS
Model AGS-4

NUMBER OF CIRCUITS—4 SPDT • SIZE—3 IN. X 2¼ IN. X 1¾ IN.
WEIGHT—6.1 OZ. • POWER INPUT—.008 AMP. @ 6 V.D.C.
SPEED REGULATION ±1.0% @ ±50.0% VOLTAGE SHIFT
ALSO AVAILABLE 1–2 OR 3 CIRCUITS

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AUTOMATIC SCREW MACHINES to 4" dia.—Also Hand Screw Machines—English & Metric Threads our specialty.

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For more information circle 128 on inquiry card.

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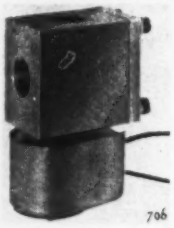
John Unertl Optical Co.
3551-3555 East Street
Pittsburgh 14, Penna.

For more information circle 129 on inquiry card.

sures are equal, poppet piston closes and static line pressure assures positive tight shut-off.—*Airmatic Valve, Inc., 7317 Associate Ave., Cleveland 9, Ohio.*

For more information circle **338** on inquiry card.

HIGH PRESSURE SOLENOID VALVE



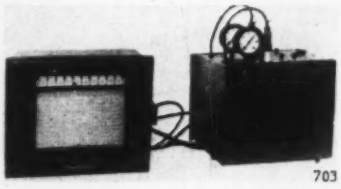
New Bulletin 8223 heavy-duty 2-way solenoid valves designed for tight shut-off on pressures to 1500 psi are of internal pilot-operated piston type; stainless steel or brass bar stock bodies with Teflon discs and stainless steel magnetic parts. Normally closed operation only. Available in ½" or ¾" pipe connections, with general-purpose, watertight or explosion-proof solenoid enclosures. —*Automatic Switch Co., Florham Park, N. J.*

For more information circle **339** on inquiry card.

MISCELLANEOUS

DEW-POINT MONITOR

New Aminco Dew-Point Monitoring System records amount of humidity present in hydrogen coolant for gen-



erators, sounds an alarm if H contains excessive moisture. System's sensing stations continuously sample H and detect its dew-point before and after drying unit.—*American Instrument Co., 8030 Georgia Ave., Silver Spring, Md.*

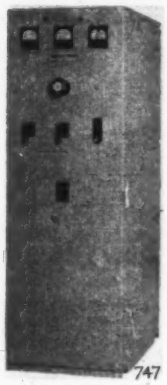
For more information circle **340** on inquiry card.

GAS DEWPOINT INDICATOR

New RAF-DPI low-priced Dewpoint Indicator for Gases, for both lab and field use, registers dewpoint from 100°F to −100°F, comes complete with carrying case and fittings. —*Robbins Aviation, Inc., 1735 W. Florence Ave., Los Angeles 47, Calif.*

For more information circle **341** on inquiry card.

DIESEL GENERATOR CONTROL

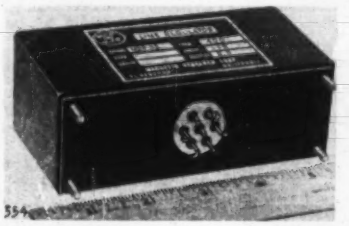

747

New floor-mounted diesel generator control cabinet in 480-v range, 35 to 250 kw, is for use with both single-unit standby installations and multiple-generator parallel service; fits modularly with standard switchboard panels. Instrumentation includes 4" voltmeter, ac ammeter, reed-type frequency meter.—*Lake Shore Electric Corp., 202 Willis St., Bedford, Ohio.*

For more information circle **342** on inquiry card.

VOLTAGE REGULATORS

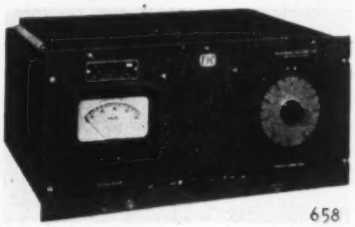
New highly-compact magnetic ac line voltage regulators for 400-cps aircraft and missile systems are announced. Shown: filament regulator (No. 75-110-0) with three outputs: (1) 115 v at 0.3 amp, (2 & 3) 6.3 v at 2.5 amp each. Input 102-124-v, 300 to 1000 cps.—*Magnetic Research Corp., 3160 El Segundo Blvd., Hawthorne, Calif.*


554

For more information circle **343** on inquiry card.

VOLTAGE REGULATOR

New Model 601 Automatic Voltage Regulator, designed specifically for lab or plant use in control of power line voltage variations, is completely independent of power factor and is particularly useful in areas where line voltage is subject to wide fluctuations.—*Tel-Instrument Electronics Corp., Dept. X, 728 Garden St., Carlstadt, N. J.*


658

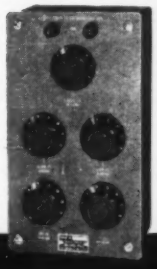
For more information circle **344** on inquiry card.

CURRENT STABILIZER

New CG 12 Current Governor is a completely-transistorized two-terminal current stabilizer, modulator and elec-

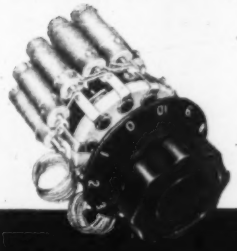
DECADE RESISTANCES

. . . with precision wirewound resistors mounted on steatite-insulated switches. *TEN* resistors per decade . . . giving better than 0.1% accuracy above 10 ohms.



DECADE BOX

Type	Dials	Ohm Steps	Total Resistance—Ohms	Price
817	3	0.01	11.1	$60.00
818	3	0.1	111	51.00
820	3	1	1,110	56.00
821	3	10	11,100	60.00
822	3	100	111,000	63.00
823	3	1,000	1,110,000	77.00
824	3	10,000	11,100,000	120.00
817-A	4	0.01	111.1	75.00
819	4	0.1	1,111	71.00
825	4	1	11,110	77.00
826	4	10	111,100	79.00
827	4	100	1,111,000	92.00
828	4	1,000	11,110,000	139.00
8285	5	0.1	11,111	94.00
829	5	1	111,110	101.00
830	5	10	1,111,100	113.00
831	5	100	11,111,000	155.00
817-C	6	0.01	11,111.1	105.00
8315	6	0.1	111,111	109.00
832	6	1	1,111,110	121.00
833	6	10	11,111,100	169.00



UNMOUNTED DECADE

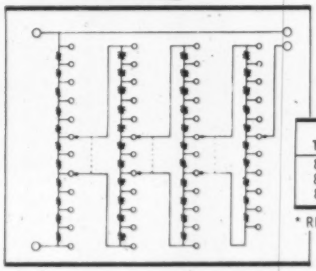
Type*	Dials	Ohm Steps	Total Resistance—Ohms	Price
435	1	0.1	1	$12.00
436	1	1	10	13.25
437	1	10	100	13.25
438	1	100	1,000	15.00
439	1	1,000	10,000	16.00
440	1	10,000	100,000	18.50
441	1	100,000	1,000,000	32.50
442	1	1,000,000	10,000,000	60.00

* Knob (#M-25594) not included. Available at additional cost.

Shallcross

DECADE VOLTAGE DIVIDERS

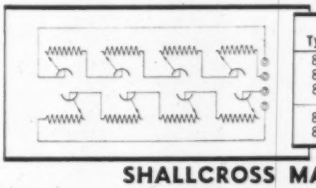
. . . same quality construction as in Decade Resistances. Choice of Kelvin-Varley or conventional potentiometer circuits.



KELVIN-VARLEY CIRCUIT

Type	Dials	Input Resistance (Accuracy ±0.05%)	Price
8350	4	10,000	$140.00
8349	4	50,000	145.00
8348	4	100,000	150.00

* RESOLUTION—Any ratio between 0.0000 and 1.0000 in steps of 0.0001.



POTENTIOMETER CIRCUIT

Type	Dials	Ohm Steps	Total Resistance (Accuracy ±0.1%)	Price
837	4	0.1	1,000	$126.00
835	4	1.0	10,000	139.00
836	4	10.0	100,000	146.00
849	5	0.1	10,000	165.00
848	5	1.0	100,000	176.00

SHALLCROSS MANUFACTURING COMPANY
510 Pusey Ave., Collingdale, Pa.

For more information circle **130** on inquiry card.

HEISE GAUGES

Indoor Oil Well

Pressures up to 20,000 psi at temperatures to 350 degrees F., encountered deep in the earth, are reproduced under laboratory control by the Continental Oil Company in testing cement slurries for use in oil well cementing.

Temperature and pressure are increased according to "Well Simulation Schedules" until the desired conditions are reached and are then held to ± 2 degrees F. and ± 10 psi to the completion of the test.

The Heise Gauge is featured in the Stanolind-Type Super Pressure Consistometer built for this work by the Refinery Supply Company, a Central Scientific Company affiliate.

Four years of accurate, trouble free performance under these extreme conditions attest the value of the Heise Gauge as a dependable precision instrument.

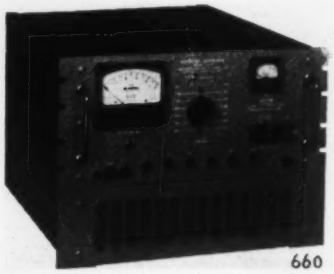
Pressure Ranges 15 to 20,000 P.S.I. Dial Sizes 8½"-12"-16"

Prices from $166.75 **DELIVERY WITHIN 30 DAYS**

HEISE BOURDON TUBE COMPANY, INC.

BROOK ROAD, NEWTOWN, CONNECTICUT, U.S.A.

For more information circle **131** on inquiry card.



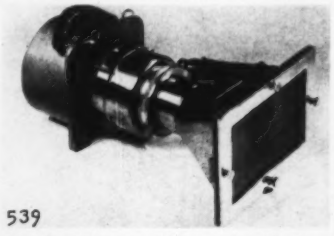
660

tronic load, with front panel selection of current levels in 50-ma steps from 0.5 amp to 30 amp. Stabilized current can be modulated 0-100% by external signals including sine wave, complex waveforms and dc.—*North Hills Electric Co., Inc., 402 Sagamore Ave., Mineola, N. Y.*

For more information circle **345** on inquiry card.

AIR SAMPLER

New Hi-Volume Air Sampler features as optional equipment a large filter holder made of stainless steel



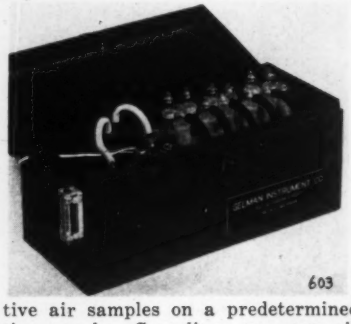
539

and aluminum, whose mouth, protected by a screen, accomodates 6" x 9" and 8" x 10" filter papers. Originally designed by N. Y. Office of AEC.—*The Staplex Co., Air Sampler Div., 777-AD-29A Fifth Ave., Brooklyn 32, N. Y.*

For more information circle **346** on inquiry card.

AIR SAMPLER

New Sequential Sampler, for air pollution and industrial hygiene studies, automatically takes 12 consecu-



603

tive air samples on a predetermined time cycle. Sampling program is quickly adjusted to user need by changing timing gears. Safety mechanisms assure that instrument will operate properly even in cases of current failure.—*Gelman Instrument Co., 233 Jefferson St., Chelsea, Mich.*

For more information circle **347** on inquiry card.

PHOTOCONDUCTIVE CELL

New 6957 head-on type of cadmium-sulfide photocell, for industrial light-operated relay applications, features extremely high illumination sensitivity which permits direct relay operation in most applications without use of amplifier. Minimum photosensitive area 0.54" x 0.65"; spectral response 3300 to 7400 angstroms with peak at 5800.—*Electron Tube Div., Radio Corp. of America, Harrison, N. J.*

For more information circle **348** on inquiry card.

ITV CAMERA

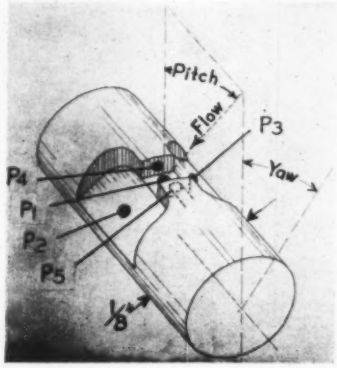
New Model PD-500 "single unit" closed-circuit television camera with associated remote-control accessories

weighs 12 lb and is completely self-contained within camera housing.—*General Precision Laboratory Inc., Pleasantville, N. Y.*

For more information circle **349** on inquiry card.

DIRECTION AND VELOCITY SENSING PROBE

New miniature probe measures flow velocity, total and static pressure and flow direction in three dimensions (two independent direction angles) for liquids and gases. Each probe is individually calibrated. Calibration is constant at all velocities



NORTHAM

HIGH RANGE PRESSURE TRANSDUCER

Length: 2½" Weight: 12 oz.

A variable inductance instrument for the measurement of steady state and transient pressures in rocket and engine testing, hydraulics research, and other applications involving high pressure measurement and control. The pressure sensing diaphragm is integral with the body, providing high resistance to shock and vibration. There are no other moving elements. May be worked with non-corrosive liquids and gases.

MODEL GP-8 SPECIFICATIONS:

Pressure Ranges: . . . . . 0-200 to 0-5,000 psig
Maximum Allowable Pressure: . . . . Twice rated pressure range
Accuracy: . . . . . ± 1% full scale
Excitation Frequency: From 60 to 20,000 cps
Natural Frequency: From 2,000 cps to 10,000 cps depending on range
Acceleration Response: Less than 1%/1,000 g along most sensitive axis (range above 1,000 psi)
Less than 1%/1,000 g axial (all ranges)

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NORTHAM PRODUCTS INCLUDE . . . Transducers for pressure, acceleration and displacement measurement and auxiliary electronic equipment for complete systems.

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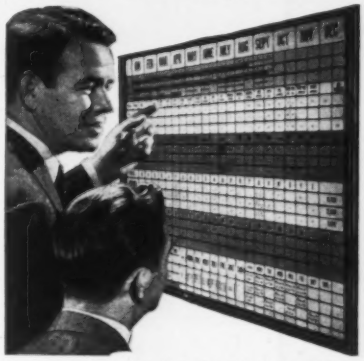
For more information circle **132** on inquiry card.

You Get Things Done With Boardmaster Visual Control



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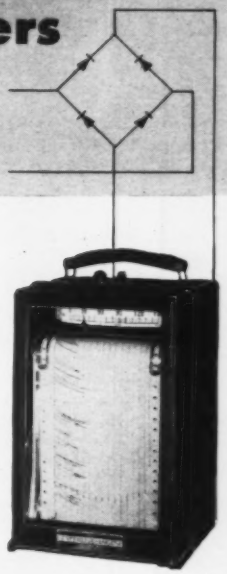
For more information circle **133** on inquiry card.

Rectifier Recorders by ESTERLINE-ANGUS



Multi-Range, Multi-Purpose AC-DC Ammeter/ Voltmeter

Several AC and DC ranges can be combined in one instrument. All ranges have uniform scales.

AC
0-50 MA, 0-1 to 0-10 Amperes.
0-50 to 0-800 Volts (20 ohms/volt)

DC
0-100 to 0-750 Millivolts
0-1 to 0-800 Volts (Approx. 24 ohms/volt)

One popular combination includes these ranges:

0-50 MA, 0-5/10 A AC
0-150/300/600 V AC } 25-800 cycles
0-150/300/600 V DC

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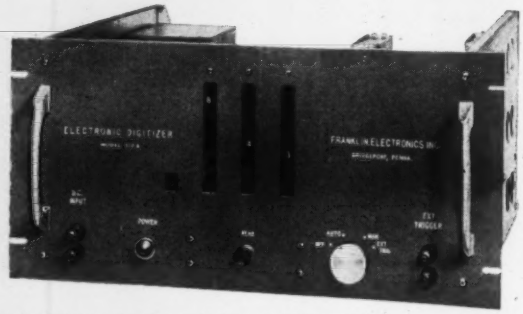
For more information circle **134** on inquiry card.

The DIGITAL VOLTMETER *with* Proved Reliability and Faster Readout for Only $1975.00 FOB



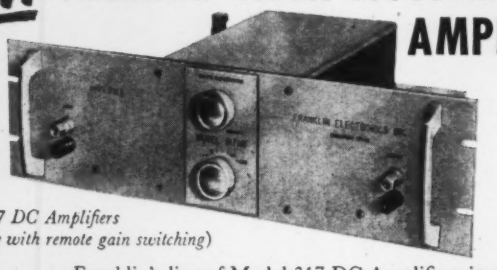
FRANKLIN MODEL 310 A DIGITIZER
IDEAL FOR PRECISION VOLTAGE MEASURING IN LABORATORY OR ON PRODUCTION LINE

This ALL Electronic digitizer has been developed as a multipurpose instrument which can be used as an analog to digital converter, voltmeter, or data reduction element. Measuring voltages from 000.0-120.0 volts it provides accuracy of 0.1% of full scale and speed of 60 readings per second, automatically or on command . . . heretofore unobtainable at this low cost. Coded outputs of each significant figure in the visual readout provide a signal source to operate matrices, printers, punches, or categorizing equipment.

FOR REDUCING DATA FROM
- *Slide Wires*
- *Thermocouples*
- *Strain Gauges*
- *Other Transducers*

FOR MEASURING
- *Strain*
- *Pressure*
- *Temperature*
- *Voltages*
- *Motion*

NEW Franklin HIGH-ACCURACY DC AMPLIFIERS



Model 317 DC Amplifiers
(Available with remote gain switching)

Franklin's line of Model 317 DC Amplifiers is especially designed to convert very low voltages (microvolt ranges) to levels useable by the Model 310 A Digitizer. Standard gain accuracy is 0.05%. Power supplied from Model 310 A.

FEI Franklin Electronics, Inc.
BRIDGEPORT, PA.

Electronic & Nuclear Development & Manufacturing

For more information circle **135** on inquiry card.

NEW INSTRUMENTS

for liquids; varies with Mach Number for gases above Mach 0.15. Various stem lengths and take-off adapters.—*Aerotech Specialties Inc., Glastonbury, Conn.*

For more information circle **350** on inquiry card.

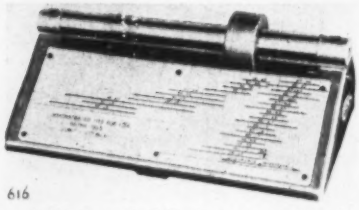
DEHYDRATORS

New standard line of steam-reactivated dehydrators for drying instrument air and process gas comprises 11 sizes, handling from 10 to 1,000 scfm (air at 70°F and 100 psig) in continuous operation with manual, semi-automatic or automatic cycling. New-design units operate on an 8-hr reactivation cycle, so that manual and semi-automatic models require attention only at change of shift, assuring regular inspection.—*Selas Corp. of America, Dresher, Pa.*

For more information circle **351** on inquiry card.

FIT DEMONSTRATION UNIT

New Limits and Fits Demonstration Unit provides the actual "feel" of a fit between shafts and holes of



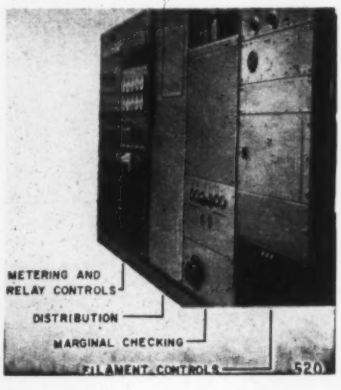
616

matching cylindrical parts; aids designers and draftsmen to avoid too-close uneconomical tolerances. Scale plate mounted in front of bar is divided vertically to represent specified clearances and horizontally to represent max and min clearance for a number of preferred fits in diameter range.—*Engis Equipment Co., 431 S. Dearborn St., Chicago 5, Ill.*

For more information circle **352** on inquiry card.

POWER CONTROL SYSTEMS FOR ELECTRONIC EQUIPMENT

New control systems feature automatic application and removal of power, gradual increase of filament voltage, sequencing of direct voltages,



voltage and temperature monitors, trouble indicators and alarms, detection of power line transients, and automatic or manual marginal checking for detection of weak components. Photo: control system for large digital computer.—*Dynamic Controls Co., 1955 Massachusetts Ave., Cambridge, Mass.*

For more information circle **353** on inquiry card.

RETICLES

New Edscorp reticles for microscopes, telescopes, etc., are said to "give far greater clarity." Made from accurate large-size drawings, they are microphotographed and reduced to their final size on transparent film. Film is sealed inside two pieces of cover glass so that image is permanently protected. Available units include horizontal scale, vertical scales, squares inside circles, step micrometers, crossline scales, concentric circles, protractors, etc.—*Edmund Scientific Co., Barrington, N. J.*

For more information circle **354** on inquiry card.

MOISTURE-CONTENT AND DENSITY MEASURER

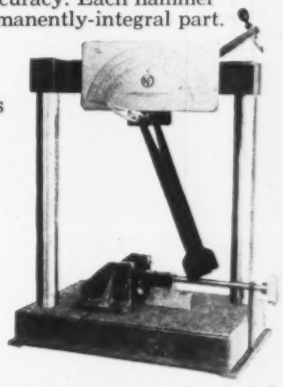
New "d/M-Gauge" portable radioactivity-type instrument measures moisture content and density of materials in simple two-minute test. Principle: measurement of varying degree that radioactivity is scattered when source is placed in contact with masses of different moisture content or density. Moisture probe contains a radioactive radium-beryllium source of fast neutrons; density probe contains a cesium-137 gamma-ray source.

Measurements are obtained by inserting selected probe into material or subsoil being tested and reading the radioactivity counter. Advantages: (1) large volume of material analyzed in a single operation: normally a spherical volume with average diameter of 14"; (2) ease of long-term studies of the same volume; (3) material is chemically and physically unchanged; (4) savings in time and labor in industry and in all sub-soil moisture or density measurements for highway construction, agricultural research, etc.—*Nuclear-Chicago, 229 W. Erie St., Chicago 10, Ill.*

For more information circle **355** on inquiry card.

impact tester

The machine that makes the Izod (cantilever beam) or Charpy (simple beam) test on each of three capacity ranges. Separate hammer for each test in each capacity range (6 hammers in all). Hammers are interchangeable. Individual calibration of each hammer assures accuracy. Each hammer is one welded unit striking bit—a permanently-integral part. Possibility of variable errors due to energy absorption by screwed-on weights and detachable bits is eliminated. Attachment of hammers is at point of suspension minimizing any effect of looseness.



FEATURES:

- Three energy scales:
  0—30 foot-pounds by .2 ft.-lb.
  0—10 foot-pounds by .1 ft.-lb.
  0— 2 foot-pounds by .01 ft.-lb.
- Combined Izod and Charpy
- Massive open frame construction
- Individually calibrated hammers—no separate weights
- Long, open linear energy scales
- Conforms to federal specification LP 406a...and ASTM St. D 256

Save Money! Buy only hammer for type and range presently needed; additional hammers may be ordered later.

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For more information circle **136** on inquiry card.

The Second
COMPUTER HANDBOOK
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DYNATROL LEVEL CONTROL

LIQUIDS
SLURRIES
SOLIDS

Model CL-10 Dynatrol utilizes dynamic type design principle for extremely accurate and versatile high-low point detection or narrow level range proportional control. This small and rugged low cost control has a positive acting electrical output response to level variation. Rated for 3000 psig—any position ¾" pipe mounting—115VAC explosion proof—no seals for leakage—corrosion resistant.

Write for Bulletin 157

AUTOMATION PRODUCTS, INC.
3030 Max Roy Street Houston 24, Texas

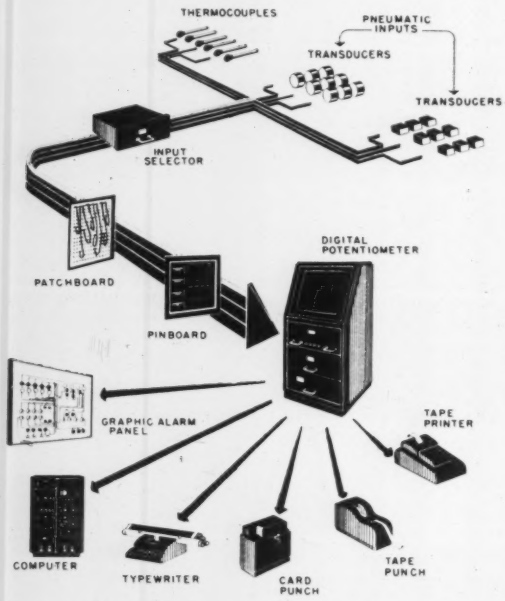
For more information circle **137** on inquiry card.

Briefs

For this literature circle number on inquiry card.

Data Handling Systems

(1) Thermocouples, flow, pressure or other transducers with linear d-c outputs proportional to the measured variable are connected to an automatic selector switch. (2) At the start of each logging cycle, a signal of fixed value is automatically fed to the Honeywell Digital Potentiometer, measured, and printed as a check on system operation and accuracy. (3) Energized by a digital clock, a programmer starts the automatic selector switch. As this switch steps



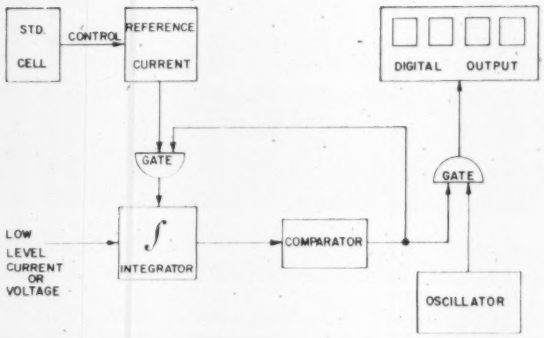
through each point to be measured, the input variable is automatically adjusted for range, span and zero suppression, then transmitted for measurement and digitizing to the Honeywell Digital Potentiometer. (4) The measured value is printed out on a suitable device, such as an automatic typewriter, with time of day and point identification. This is done at a rate faster than one point per second. During logging, if an off-normal point is detected, its value is printed in red . . . (*From new 8-page Bulletin D* 150-1, *Minneapolis-Honeywell Reg. Co., Systems Engineering, Wayne & Windrim Aves., Phila.* 44, *Pa.*)

For this literature circle **401** on inquiry card.

DADIT—A-D Integrating Translator

The DADIT system functions basically by time division of a standardized reference current, or resistance, to a condition of balance against the applied input. The simplified system diagram illustrates the case of an input current digitized against a standardized reference current.

The operating cycle is determined by dividing a stabilized clock frequency by 100 kcs. The cyclic rate is typ-



ically about 10 cps. The time ratio is then digitized by scaling the clock frequency during the time periods when the reference current is gated into the input circuit. During the repetition period, typically two seconds, half of the operating cycles (10 consecutive cycles) are ignored as a stabilizing period, and half (the next 10 consecutive cycles) are scaled for the digital readout. In multiplexed operation the input is switched during the early portion of the ignored half period. The operational d-c amplifier performing the integrating function through the feedback capacitor is a Weston Inductronic amplifier which has the ability to average the switching transients accurately. This avoids the amplifier bandwidth as an error determinant by including the amplifier response delay as simply a part of the operating integal. Digital Resolution: 1 part in 10,000; Analog Resolution cold start—5 microvolts or 0.1 microampere; after warmup—1 microvolt or 0.02 microampere. . . (*From new Bulletins* 102 *and* 104, *Daystrom Systems,* 5640 *La Jolla Blvd., La Jolla, Calif.*)

For this literature circle **402** on inquiry card.

Universal Bridge

The B.221 is a highly accurate transformer ratio arm bridge of advanced design. It provides facilities for two, three or four-terminal measurements of impedance or transfer admittance over an extremely wide range at an operating frequency of 10,000 radians/sec. (1592c/s).

T_1 is a voltage transformer to the primary of which the source is connected. The secondary winding is tapped to form one of the ratio arms of the bridge. The detector

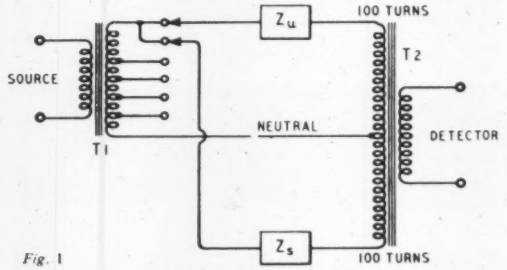


Fig. 1

circuit is connected to the secondary of the current transformer T_2, the primary winding of which is tapped to provide the second ratio arm. The neutral or third terminal of the bridge is connected between the two transformers . . . In Fig. 1, the same voltage from the secondary of T_1 is applied to both the standard impedance Z_s and the unknown impedance Z_u. Assuming that $Z_u = Z_s$, then the ampere turns produced in the two primary windings of T_2 are equal in magnitude but opposite in phase, and the resultant core flux is zero. No voltage will therefore be developed across the windings, and the detector will indicate balance.

When the impedance Z_u and Z_s are unequal, balance can be restored by adjusting the value of Z_s and by connecting Z_s to a different tapping on the voltage transformer . . . (*From new 4-page Bulletin WK-B-221, Robertshaw-Fulton Controls Co., Instrument Div.,* 2920 *N.* 4 *St., Phila. Pa.*)

For this literature circle **403** on inquiry card.

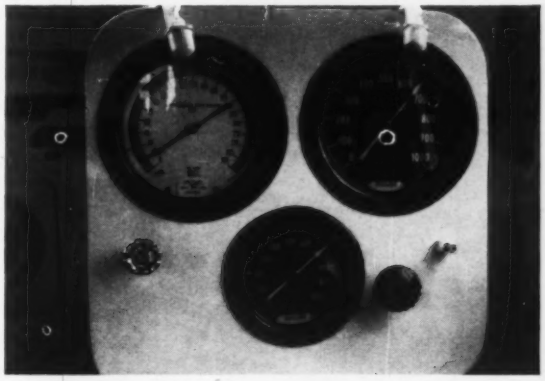
Photos courtesy of the Dodge Division of the Chrysler Corporation

Dodge Relies on **ASHCROFT DURAGAUGES** in Special Tests

To obtain scientific proof of the greater pulling power of the Dodge D100 pickup truck as against that of several comparable makes, Dodge engineers used Ashcroft Duragauges. The gauges were installed in the cab of a special dynamometer truck which was hitched in succession to the test trucks.

The Duragauges accurately indicated the varying restraining forces exerted by the dynamometer truck and the pressure in the instrument lines themselves. By photographing the dial indications at predetermined travel speeds, authentic records of each test were obtained.

The use of Ashcroft Duragauges in these certified tests is another acknowledgment of their reputation for high accuracy . . . primarily achieved by the use of a geared movement that rotates around a fixed center. It provides the most efficient transmittal of mechanical motion and assures positive pointer position. Furthermore, to guarantee correct calibration and to prevent slippage or parting under tension, a one-piece link connects the movement and Bourdon tube. The tube is extra wide — highly sensitive to slight pressure changes. To insure calibration stability, each tube assembly is "whip-tested" at pulsating pressures approximately 50% higher than its pressure rating.



ASHCROFT DURAGAUGES accurately indicate or record pressure of steam, air, water, oil, gas and other media — 30" vacuum or a few ounces up to 100,000 psi. Eight Bourdon tube materials available. Cases made of Alumalife®, cast iron and phenol meet the widest range of services. Numerous dial sizes. Choice of all-stainless-steel movement or stainless-steel movement with nylon bearings and pinion gear.

YOUR INDUSTRIAL SUPPLY DISTRIBUTOR will gladly help you select the right Duragauges for special tests or everyday measurement of pressures. Whatever your application requirements, you can rely on Ashcroft Duragauges for highest sustained accuracy and durability.

In Canada: *Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario*

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ACCURATE CO_2 Analysis in 40 Seconds!

Other outstanding features of the FYRITE CO_2 Indicator are its durable, fool-proof construction and unmatched convenience of operation. It requires no setting-up, has no valves or leveling bottle to manipulate.

The FYRITE measures CO_2 directly by the fundamental method of chemical absorption. Consequently, the reading is independent of voltage, humidity, temperature, or atmospheric pressure conditions.

Comes complete with chemical charge good for at least 300 readings. Replacing chemical merely requires removing four screws that hold top assembly in place.

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100% AUTOMATIC
REMOTE READING
Tank Contents Gauges

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- UNDERWRITERS' APPROVED

Liquidometers use a temperature compensated balanced hydraulic system. Indications unaffected by changes in specific gravity. All models feature large easy-to-read dials. UL approved switches available.

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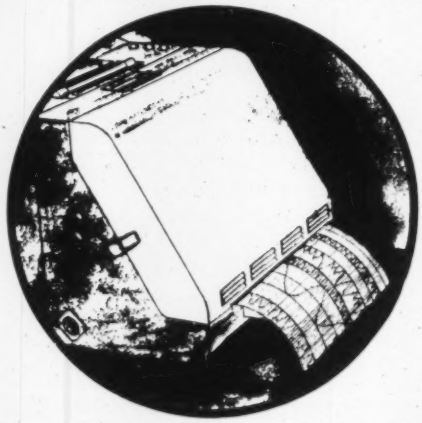
BRIEFS—CONTINUED

Rapid-Access Magazine

Using an exclusive high-speed system of "flash-processing," the 5-036 Datarite Magazine chemically develops an oscillogram at rates up to 25 inches per second . . . For the purpose of describing its principle of operation, the 5-036 can be thought of as performing three separate operations, which in practice occur almost simultaneously:



1. Exposure of the silver halide emulsion to the input data signals. 2. Application of a thin film of developer to the *emulsion side only* of the record. (Only enough developer is applied to wet the emulsion layer, leaving the paper-base dry.) 3. Application of heat. (Heat accelerates the development so that it occurs within a fraction of a second, and simultaneously dries the emulsion, thus stopping further development.) These steps comprise the

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Illustrates instruments and gages...*diagrams* their installation and on-the-job use... *charts* valuable performance data.

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For more information circle **141** on inquiry card.

action described as "flash-processing" and can be completed in a fraction of a second. Following this rapid sequence, the record is fed continuously from the magazine . . . (*From new 4-page Leaflet 1598, Consolidated Electrodynamics Corp., 300 North Sierra Madre Villa, Pasadena, Calif.*)

For this literature circle **404** on inquiry card.

Slides-On-The-Spot

You snap the shutter, pull the tab and in a couple of minutes there's a transparency which can be put to many uses—projection, diazo copies, publication, television, etc. . . . A mounted ready-to-use slide costs about 55 cents. Surveys indicate an average commercial price range of $1.50 to $2.25 for conventional slides.

Slides-on-the-spot are being used in oscillography, education, etc., etc. Allen B. Dumont Laboratories and Fairchild Camera & Instrument Corp. both have cameras that will make exposures of successive tracings on the same transparency. A 2¼"x2¼" transparency can be projected to 12'x12'. . . . (*From new 8-page Bulletin F 1870A, Polaroid Corp., Cambridge 39, Mass.*)

For this literature circle **405** on inquiry card.

Heatless Air Dryer

The dramatic new concept—providing constant superdry air or gas flow without the need for (or problems created by) the use of regenerative heat—is simply and efficiently achieved by utilizing the natural properties of desiccants to come to equilibrium with their surroundings. Eighteen models available. Chamber sizes for 2" up. Handles flows from 2 to over 1800 standard cubic feet a minute.

Provides effluent dewpoints of −100° to −140°F continuously, regardless of even major fluctuations in the temperature of the gas or air . . . (*From new 4-page Bulletin DD170, Trinity Equipment Corp., Roselle Park, N. J.*)

For this literature circle **406** on inquiry card.

DEHYDRATION OF GASES

HI-LO PRESSURES

HI-LO FLOWS

"PAT. PEND."

- New Leakproof Design — Chambers and Cartridges "O" Ring sealed, no possibility of gas bypassing the cartridge.
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- Manual or Automatic Units. Portable, stationary or airborne installations.

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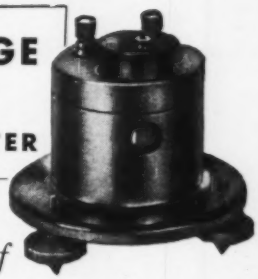

—a sensitive galvanometer of rapid response

This instrument is especially suited for work where high sensitivity combined with rapid response is required. May be used with lamp and scale or photographic recorder. Performance data for periodic time of 0.1 second is shown below, but instruments are available for shorter periods down to approximately 0.02 second.

Coil Resistance ohms	Periodic time Seconds	Sensitivity m.m./μA at 1 meter	External Resistance for Critical Damping
300	0.1	100	4000
20	0.1	20	100

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control temperature to ±0.01°C with

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This new PRINCO Thermoregulator, covered by U.S. Patent No. 2,498,212, brings new accuracy, sensitivity and ease of adjustment to automatic temperature control. A rough adjustment is made by the mercury overflow chamber and a fine adjustment to ±0.005°C is made by means of a rotating magnet.

With the PRINCO "Magna-Set" Thermoregulator properly designed agitated baths can be controlled to ±0.01°C within the limits of minus 35 to plus 300°C.

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Use the portable **ENGRAVOGRAPH** to mark legend plates to your specifications, on the spot, when you need them—with unskilled labor, because it's tracer-guided. Big savings on short runs and "one-shot" jobs. Eliminates costly delays. Over 17,000 in use.

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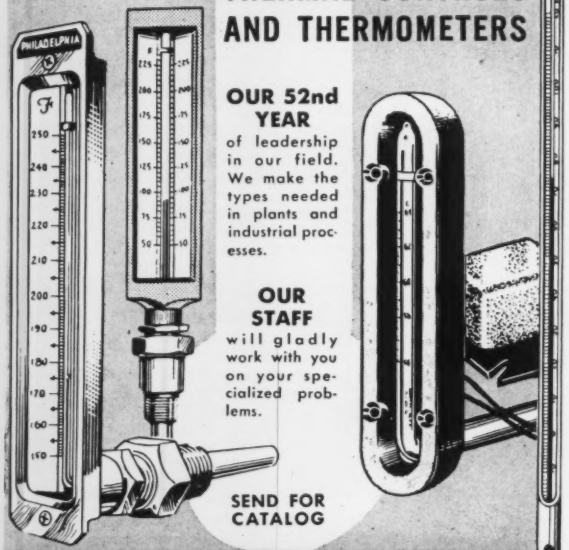

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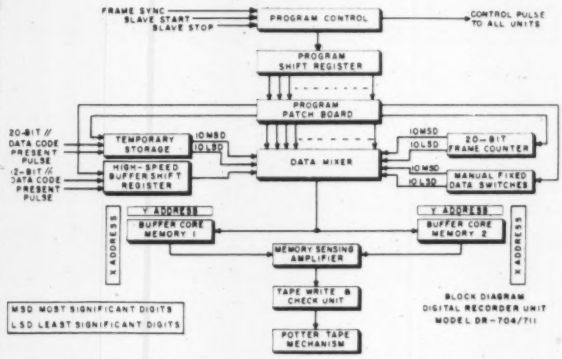
For more information circle **145** on inquiry card.

BRIEFS —CONTINUED

Digital Recorder Unit

A recorder with a brain, the Epsco Model DR-704/711 Digital Recorder Unit will accept digital data from any source at arbitrary rates and prepare magnetic tapes, complete with parity checks, for direct entry into digital computers.



Inputs are provided for 12-bit parallel data words and 20-bit parallel data words, both of which can occur at asynchronous times and at non-uniform rates. In addition, the unit can receive 12-bit word present pulses and 20-bit word present pulses, record synchronizing pulses to indicate the beginning of a commutated or multiplexed cycle, and slave start and slave stop commands to control the digital recording so as to permit quick-look editing . . . (*From new 5-page leaflet "Model DR-704/711," Epsco Incorporated, Commonwealth Ave., Boston 15, Mass.*)

For this literature circle **407** on inquiry card.

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Quantity production of standard and special coatings to your exact specifications

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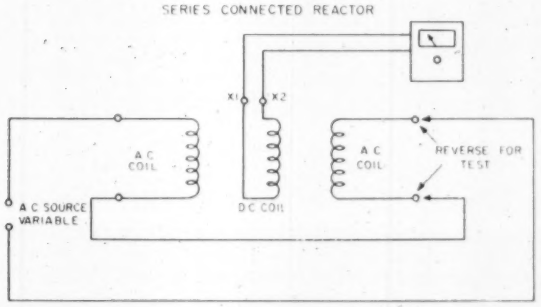
For more information circle **146** on inquiry card.

Saturable Power Reactors

A power reactor is a variable inductive device somewhat similar to a common choke coil. With the inclusion of a control winding the "choke coil" reactance can be varied and present a variable impedance to the source of power. The reactor is connected in series with the load and by

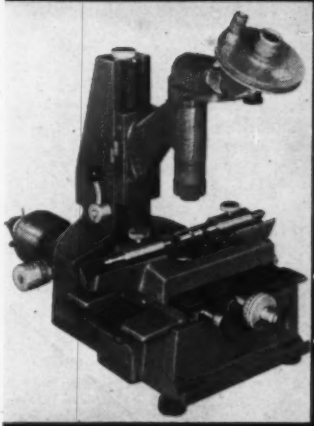


means of direct current in the control winding varies the current in the load. The relationship between the DC current and the AC current is nearly linear and the percentages of DC power to the AC power are in the order of less than 1%. Oftentimes large size reactors in excess of 50 KVA may be operated with a wattage ratio as low as 0.4%.

The output power is controllable between a relatively low power to 81%. This is done by controlling the amount of DC current allowed to flow to the reactor control winding. This presents a means of smoothly and steplessly controlling AC power to a load . . . (*From new 32-page Bulletin F-8383, Barber-Colman Co., Wheelco Instrument Div., Rockford, Ill.*)

For this literature circle **408** on inquiry card.

A JOB THAT ONLY A Leitz TOOLMAKER'S MICROSCOPE CAN DO!



- Permits measurements in 2 dimensions plus checking of Radii, Concentric Circles, threads and angles.
- Has exclusive intermediate image system which combines coordinate measuring microscope and optical comparator in one instrument.
- Built-in charts permit use in three magnifications.
- Reads to .0001" or to .00005" from Master glass scales in larger models.
- Available in 1" x 2", 1" x 4", 2.3" x 6", 6" x 6" and 8" x 40" capacity.

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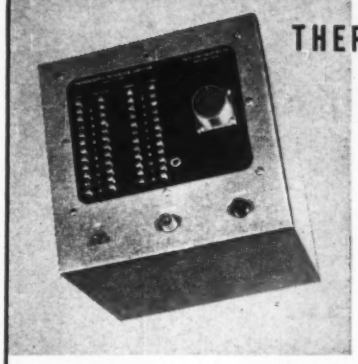
For more information circle **148** on inquiry card.

PACE

THERMOCOUPLE REFERENCE JUNCTION



RJ SERIES THERMOCOUPLE REFERENCE JUNCTIONS operate from 115 volt line to provide thermostatically controlled temperature reference for multi-channel thermocouple systems. Reference Junction permits use of copper lead wire without inconvenience of ice-bath maintenance, and eliminates necessity for cold-junction compensation.

Features . . .

Temperature stability within ½°F, and uniformity within 0.1°F.
Control temperature adjustable.
Multi-wire junctions available for thermocouple choice in each channel.
Variety of thermocouple types, number of channels and input-output connections offered in standard models.

PACE *engineering company*
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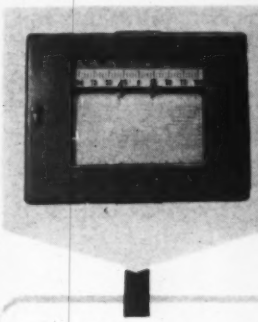

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The SCHAEVITZ two-pen recorder* will measure and compare position, thickness, contour, force, pressure and similar variables. The Series R2, 11" recorder has two separate null-balance measuring systems using the SCHAEVITZ LINEAR VARIABLE DIFFERENTIAL TRANSFORMER in pick-ups and transducers. No standardization cells or sliding contacts are used.

OTHER FEATURES INCLUDE:

ACCURACY: better than 0.5%
RESOLUTION: stepless
CHART AND SCALE: 100-0-100
PEN SPEED: 2 seconds for 5½" full scale
CHART SPEED: ranges available from 2" per hour to 240" per minute
RANGES: 1x and 0.5x
VOLTAGE AND FREQUENCY: 115V, 60 cycles, AC

*SCHAEVITZ single pen 11" strip chart recorder also available. Write, wire or call for complete information.

schaevitz engineering

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For more information circle **149** on inquiry card.

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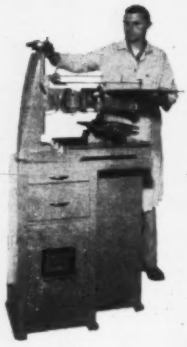
- Fastest possible copy set-up
- Greatest ease and speed of adjustments
- Cutter grinders, rotary tables, master letters, compound slides, name plate blanks and all required accessories



MODEL D2 HEAVY-DUTY 2-DIMENSIONAL

- 575 pounds-rigid, sturdy, precise
- Vertical adjustment of copy table automatic with Pantograph
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- Ball bearing construction throughout — super precision ball bearings in spindle
- Ratios 2 to 1 to infinity — master copy area 26" x 10"

MODEL 106 PORTABLE BENCH MODEL- 2- OR 3-DIMENSIONAL

- 40 pounds of unbeatable speed and accuracy at a reasonable price
- Perfect for all machining applications within its range
- Ball bearing spindle has three speeds up to 14,000 rpm
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If you design electric or electronic devices of any kind such as wave guide tubes, UHF tuners and cavities, voltage regulators, capacitors, dashpots, etc., investigate the economy and efficiency of precision glassware. Our engineers welcome the opportunity of discussing any of your design problems with you. Send for our new bulletin today.

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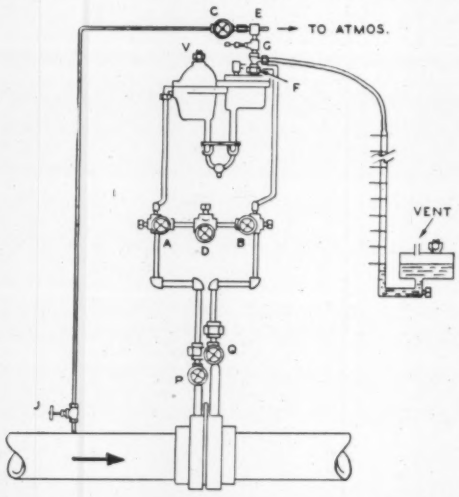
BRIEFS—CONTINUED

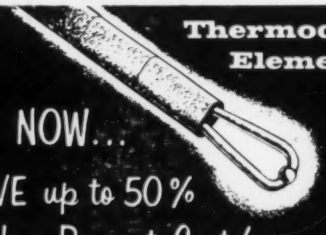
Flowmeter Calibrator

Ejector (for meter calibration without removal of meter from the line) induces a vacuum in the low pressure me-



ter chamber, permitting the high-pressure chamber—containing the float mechanism—to remain open during calibration . . . (*From new 60-page Catalog 500, "Accessories and Supplies", Foxboro Company, Foxboro, Mass.*)

For this literature circle **409** on inquiry card.



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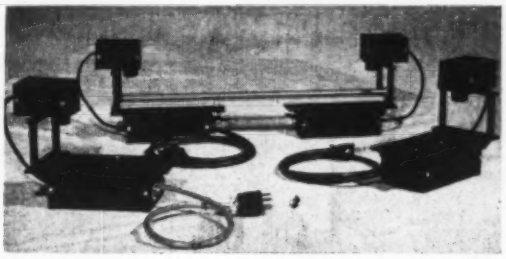
For more information circle **152** on inquiry card.

Zone Control Feeding of Small Parts

With a feeding device such as the available, very efficient, vibratory bowl type equipment; the parts cause either (a) the track of bowl to become jammed with interlocked parts, (b) the track of bowl plus the transfer tracks section to become jammed with parts, or (c) the excess parts being conveyed by the bowl track meet with



resistance formed by a full magazine or transfer section and fall off the track back into the bowl . . . Hence to determine or register when the magazine section is full, in order that the feeding equipment may be stopped; a photo-cell system provides a solution. . . The reduction in candlepower requirement, due to closer proximity between light source and receiver, also contributed or made possible the selection of a Crystal Diode photo-cell as the pick up or receiver . . . As a result we have, as shown in the picture, produced a unit designed to mount under a typical track section with supports for light source straddling the track . . . (*From new 4-page reprint, Vickers Machine & Tool, Inc.*, 1394 *South 22nd St., Columbus* 16, *Ohio*)

For this literature circle **410** on inquiry card.

GUBELMAN CHARTS

ALL TYPES

for Recording Instruments

★ Continuous Roll

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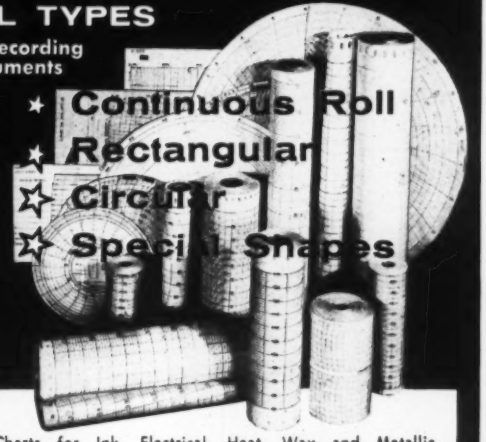
☆ Circular

☆ Special Shapes



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Special time numbering, perforations, and graphic design cycles available to meet unusual requirements.

All Charts are produced under automatically controlled atmospheric humidity conditions.

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May we help solve your recording chart problems?

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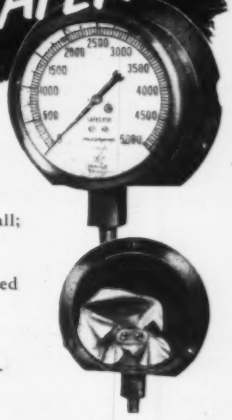
New advance in... GAUGE SAFETY



Another Marsh development... new "SAFE-CASE" gauge for those conditions where over-pressures of explosive force can occur.

Face well protected by solid metal wall; but, still more important, *entire back* is thin metal plate that opens out to exhaust any abnormal pressure.
In testing, heavy blank cartridges, fired within back of case, did not even break crystal.

Use "Safecase" for your toughest services. It is standard in Marsh "Mastergauge"—the highest development in pressure gauges.
Ask for facts.

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Sales affiliate of Jas. P. Marsh Corp.
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HOUSTON BRANCH PLANT: 1122 Rothwell St. Sect. 15, Houston, Texas
Marsh Instrument & Valve Co. (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada

Test Proves Safety
Explosive force of cartridge merely opens out safety-release back. Back is firmly attached to case and cannot be dislodged during a pressure blow-out.

MARSH GAUGES

For more information circle **153** on inquiry card.

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ALL TYPES KNOWN GLASS

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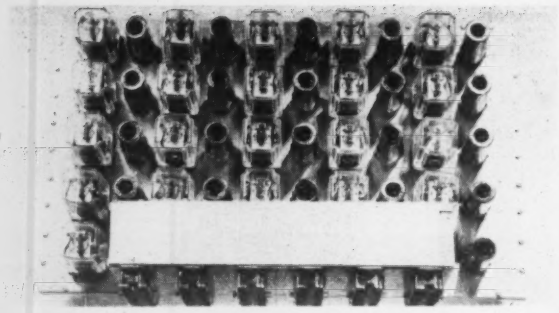
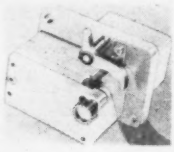


DIGIVERTER



Electronically converts binary coded digital information from punched paper tape into selected functions, up to 64, with any desired code of six binary digits or less.

The first and only unit of this type commercially available, the DIGIVERTER fulfills a basic need in industry, business, civil defense and other military groups.

Suitable for control and full operation of a solenoid-actuated typewriter, DIGIVERTER can be used as a low-cost practical centralized operations control to perform any required remote-control function regardless of associated equipment in the system.

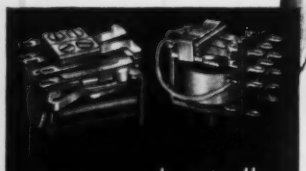
Exclusive use of hermetically-sealed relays and cold cathode tubes insures long life and provides reliable continuous operation.

COMMERCIAL AUTOMATION PRODUCTS CO.

G. P. O., 1027 New York 1, N. Y.

For more information circle **155** on inquiry card.

Comar relays fit your product like a glove...



THEY FIT *electrically*

THEY FIT *mechanically*

THEY FIT *economically*

• Every Comar relay is custom-designed exactly to fit your requirements. It has precisely the electrical characteristics, the physical size, the mounting, demanded by your specifications. Yet, this "custom-fitting" costs no more than ordinary relays. Inquiries invited.

Comar ELECTRIC COMPANY

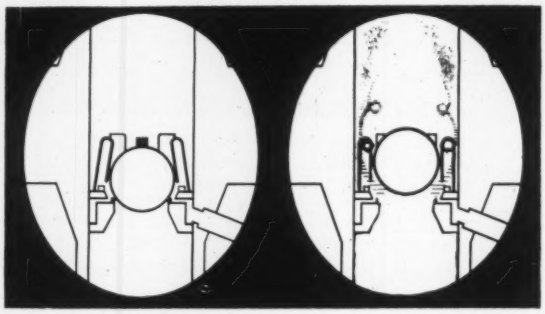
3349 ADDISON ST., CHICAGO 18, ILLINOIS

RELAYS • SOLENOIDS • COILS • SWITCHES • HERMETIC SEALING

For more information circle **156** on inquiry card.

Variable-Orifice Desuperheater

When there is no flow, a weighted steel ball seats itself on a ring, closing a self-regulating annular orifice. In operation, incoming steam lifts the ball an amount determined by weight of the ball and amount of steam flow.



CLOSED OPEN

Each rate of flow gives the ball a different position, with a practically-constant pressure drop—normally 3 to 4 psi—for all flows . . . Cooling water flow is controlled by a diaphragm-operated Copes-Vulcan valve responsive to the temperature controller . . . There is one moving part—the ball. It is held in correct concentric position by springs of special design made of Inconel to resist corrosion and erosion. . . (*From new 4-page Bulletin* 1037, *Copes-Vulcan Div., Blaw-Knox Co., Erie* 4, *Pa.*)

For this literature circle **411** on inquiry card.

For after shutdown protection...

AGASTAT®

TIME DELAY RELAY

Allows operation of auxiliary protective devices* after operating cycle is stopped. Easily installed in any electrical line.

The AGASTAT is—

- light, versatile, dependable.
- instantaneous recycling.
- unaffected by voltage variations.
- adjustable in timing from 0.1 second to more than 10 minutes.
- available in models that offer delays on energizing and de-energizing, two step delays, manually-actuated time delay switch, remote push button control.

***Write for new 4-page application folder describing how one large company solved its after-operating problem. Address Dept. A21-119**

AGA DIVISION

Elastic Stop Nut Corporation of America

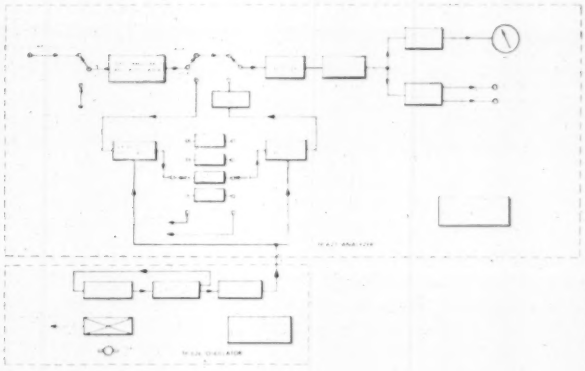
1027 Newark Avenue, Elizabeth, New Jersey

Pioneers in pneumatic timing.

For more information circle **157** on inquiry card.

Frequency Analyzer

The TP-625 Frequency Analyzer determines the frequency and amplitude of the individual components of a complex wave within the frequency range of 2 to 25,000 cycles . . . Results are indicated on a calibrated attenu-



ator and on a meter . . . When equipped with its auxiliary equipment, the TP-629 Control Panel and the TP-628 Servo Drive, the TP-625 Frequency Analyzer will automatically track to a frequency established by the speed of the equipment under analysis . . . (*From two new 4-page bulletins "TP-625 Frequency Analyzer," Technical Products Co., Instrument Div., 6670 Lexington Ave., Los Angeles 38, Calif.*)

For this literature circle **412** on inquiry card.

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THE RIGHT GAUGE FOR YOUR SPECIFIC NEEDS

- PRESSURE
- VACUUM
- COMPOUND
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- COMBINATION
- DIAPHRAGM
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Accurately RECORD calorific values of gases from 80 B.t.u.'s and up

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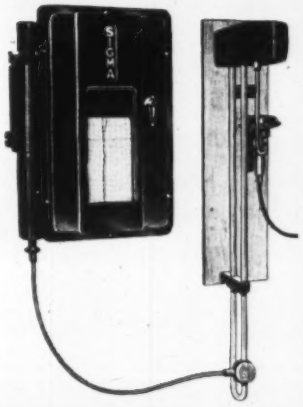
- Simple in design
- Ruggedly built
- Free from continuously moving parts—except for chart drive
- Low in cost



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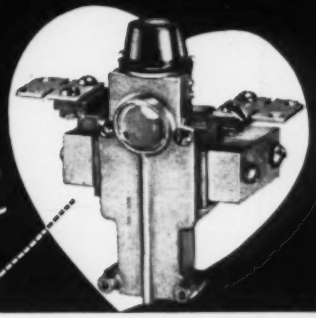
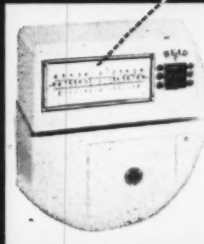




IN THE AUTOMOTIVE FIELD, the Bear Manufacturing Co. of Rock Island, Ill. uses Series 500 G-M Galvanometers in its new remote-reading Electric Wheel Alignment System (left). Whatever your own particular instrument field, you can achieve this same self-contained portability, ruggedness and high sensitivity with G-M Galvanometers. Complete catalog on request.

GM LABORATORIES • INC.
4316 NORTH KNOX AVE., CHICAGO 41

For more information circle **160** on inquiry card.

INSTRUMENTS and AUTOMATION

New Literature

AUTOMATION

HEAT-TREATING. 24-page Catalog TD2-620 (1) describes effect of steam atmosphere heat treating on high-speed tool steel, cast iron, powdered iron, etc., also furnace and control equipment for this process.—Leeds & Northrup Co., 4934 Stenton Ave., Phila. 44, Pa.

Circle **414** on inquiry card.

AUTOMATION for process industries is treated in 16-page illustrated brochure written in non-technical language, which clarifies some broad aspects of automation and indicates its application within the process industries.—Patterson-Emerson-Comstock, Inc., Automation Div., 313 E. Carson St., Pittsburgh 19, Pa.

Circle **415** on inquiry card.

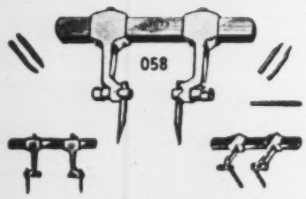
MINIATURE AIR CYLINDERS, valves, manifolds, and fittings are described in 8-page booklet "Push Button Aids to Automation."—Clippard Instrument Laboratory, Inc., 7390 Colerain Rd., Cincinnati 39, Ohio.

Circle **416** on inquiry card.

Eliminate makeshift or expensive special jigs with the . . .

ROLYN

ADJUSTABLE Key Spanner



An indispensable tool for Scientific Instrument Makers, Repairmen, Engineers, Electricians, Wireless Mechanics, Motor Engineers.

Now you only need *one* tool for removing or securing Internal or External Locking Rings • Bushings • Collets • Thrust Collars • Internal Cells, countless other adjustments.

The Key Spanner is easily adjustable for diameter and depth giving a positively rigid action up to a maximum capacity of 3" diameter.

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For more information circle **161** on inquiry card.

TURRET LATHE DRIVE. Four-page folder describes completey automatic operation for Jones & Lamson standard turret lathes.—Jones & Lamson Machine Co., Springfield, Vermont.

Circle **417** on inquiry card.

PROCESS CONTROL. Eight-page booklet describes new Series E Accu-Ray equipment featuring complete accessibility.—Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus 12, Ohio.

Circle **418** on inquiry card.

PHOTOELECTRIC CONTROL. Four 2-page loose-leaf bulletins and 2-page Instruction Sheet, describe over a dozen different applications of Electronic Eye Systems.—Basic Controls Inc., 1714 Westwood Blvd., Los Angeles 24, Calif.

Circle **419** on inquiry card.

MOTORS, SERVOS

POSITION SERVOS. 8-page Application Bulletin No. 39.2 discusses operation and uses of pneumatic-hydraulic position servos for production machinery.—Askania Regulator Co., 240 E. Ontario St., Chicago 11, Ill.

Circle **420** on inquiry card.

FHP GEARED MOTORS. Two-page bulletin describes standard stock Model SG-15 with 16 output speeds.—Merkle-Korff Gear Co., 213 N. Morgan St., Chicago 7, Ill.

Circle **421** on inquiry card.

TEMPERATURE

THERMOCOUPLE GLAND. New 4-page Bulletin MTG describes new Midget Thermocouple Gland, only 1½" long x ½" hex, which also seals pressures from 0.005 microns to 5.000 psi.—Conax Corp., 2300 Walden Ave., Buffalo 25, N. Y.

Circle **422** on inquiry card.

INFRARED RADIOMETRY. Four-page Bulletin 1210 describes Model R-4D1 OptiTherm industrial radiometer.—Barnes Engineering Co., 30 Commerce Rd., Stamford, Conn.

Circle **423** on inquiry card.

THERMOCOUPLE CHART. Durable chart contains color codes and calibration symbols for thermocouples and thermocouple extension wires plus pyrometer wire resistance figures.—Thermo Electric Co., Inc., Saddle Brook, N.J.

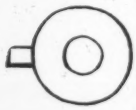
Circle **424** on inquiry card.

THERMOMETERS. 4-page bulletin describes lance type thermoelectric thermometer with indicating instrument mounted directly on rigid probe, and remote-probe type.—Royco Instruments, 722 Arthur St., Albany, Calif.

Circle **425** on inquiry card.

THERMOSTATS. 4-page Technical bulletin THSN-4A gives revised data on Klixon C4344 Series Thermostat.—Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.

Circle **426** on inquiry card.



FLOW

RING BALANCE METERS for measuring flow-rate, etc. are described in technical detail in 8-page Specification Sheet PM-10002.—Hagan Chemicals & Controls, Inc., Hagan Bldg., Pittsburgh 30, Pa.

Circle **427** on inquiry card.

AIR AND VACUUM PUMPS are described in 16-page catalog on positive rotary pumps, air motors, etc.—Leiman Bros., Inc., 146-181 Christie St., Newark 5, N. J.

Circle **428** on inquiry card.

WEIGHT, FORCE, PRESSURE, VACUUM

VACUUM FITTINGS. 28-page Bulletin 10-1 contains detailed descriptions of high-vacuum valves, baffles, traps, and combination valve-and-baffle; includes Selection Guide and technical data.—Rochester Div., Consolidated Electrodynamics, 1775 Mt. Read Blvd., Rochester 3, N. Y.

Circle **429** on inquiry card.

ELECTRICAL WEIGHING. 4-page Bulletin 657-B18 describes Ametron Electronic Crane Scale which combines weighing and transportation operations.—Streeter-Amet Co., Grayslake, Ill.

Circle **430** on inquiry card.

LOAD CELLS, New 4-page Bulletin M-27 describes tension and compression load cell systems which operate under adverse shock-loading and/or continuous vibration.—Martin-Decker Corp. 3431 Cherry Ave., Long Beach 7, Calif.

Circle **431** on inquiry card.

AIR COMPRESSORS. Three new pieces of literature describe entire line of Westinghouse unit type and Le Roi stationary air compressors, ½ to 100 hp, single-and two-stage units.—Sales Promotion Dept, Le Roi Div., Westinghouse Air Brake Co. Milwaukee 1, Wis.

Circle **432** on inquiry card.

VACUUM GAGES. New 2-page Data Sheet No. 560 describes new electrical vacuum gages for continuous measurement of very low absolute pressure, featuring noble-metal elements.—Vacuum Equipment Div., F. J. Stokes Corp., 5500 Tabor Rd., Phila. 20, Pa.

Circle **433** on inquiry card.

VERY-HIGH PRESSURES. 2-page bulletin describes Parabar which provides 450,000 psi in chamber ½" dia by 10" high.—Nucor Research, Inc., 2421 Wolcott, Ferndale 20, Mich.

Circle **434** on inquiry card.

INSTRUMENT AIR DRYER using desiccant which slowly dissolves and is never removed or regenerated is described in new 12-page Catalog D1-957 NE 10. Contains tabulation of available sizes.—Van Products Co., 5700 Swanville Rd., Erie, Penna.

Circle **435** on inquiry card.

STRAIN GAGES, 4-page technical bulletin describes new Weldable Strain Gages, installed in one minute.—Micro-Test, Inc., 657 N. Spaulding Ave., Los Angeles 36, Calif.

Circle **436** on inquiry card.

MISCELLANEOUS VARIABLES

LIQUID LEVEL GAGE. Two-page Data Unit #306 describes new magnetic gage for safely gaging explosive or inflammable liquids.—Jerguson Gage & Valve Co., 80 Adams St., Burlington, Mass.

Circle **437** on inquiry card.

VISCOMETRY. 16-page operating manual VIM 57 is for maker's viscometers. (Give model and serial numbers of instrument when requesting.)—Brookfield Engineering Labs., Inc., Stoughton 36, Mass.

Circle **438** on inquiry card.

LEVEL INDICATION. New 2-page Bulletin D-22 describes a new system for granular-material level indication and control.—Femco, Inc., Irwin, Pa.

Circle **439** on inquiry card.

MAGNETIC PICKUPS. 4-page bulletin describes transducers for measurement of displacement, velocity or acceleration.—Industrial Div., Sanborn Co., 175 Wyman St., Waltham 54, Mass.

Circle **440** on inquiry card.

MOISTURE CONTROL in free-flowing solids is treated in 4-page Bulletin QE 856 on the Quaker RMC Moisture Controller.—Fielden Inst. Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth Street, Phila. 33, Pa.

Circle **441** on inquiry card.

TURBIDIMETRY. 2-page Bulletin 531 describes Photoelectric instruments for turbidity and dust.—Ess Instrument Co., Bergenfield 22, N. J.

Circle **442** on inquiry card.

OPTICAL

INFRARED INSTRUMENTATION. Two new 2-page Bulletins, TDS 1380 and 1370, describe (1) infrared radiation standard, and (2) Type UV-IR photometer; while two 4-page Bulletins, TDS-IRPS and TDS 1000, deal with (3) radiation pyrometers, and (4) arsenic trisulfide glass lenses and windows.—Servo Corp. of America, 149 Denton Ave., New Hyde Park, N. Y.

Circle **443** on inquiry card.

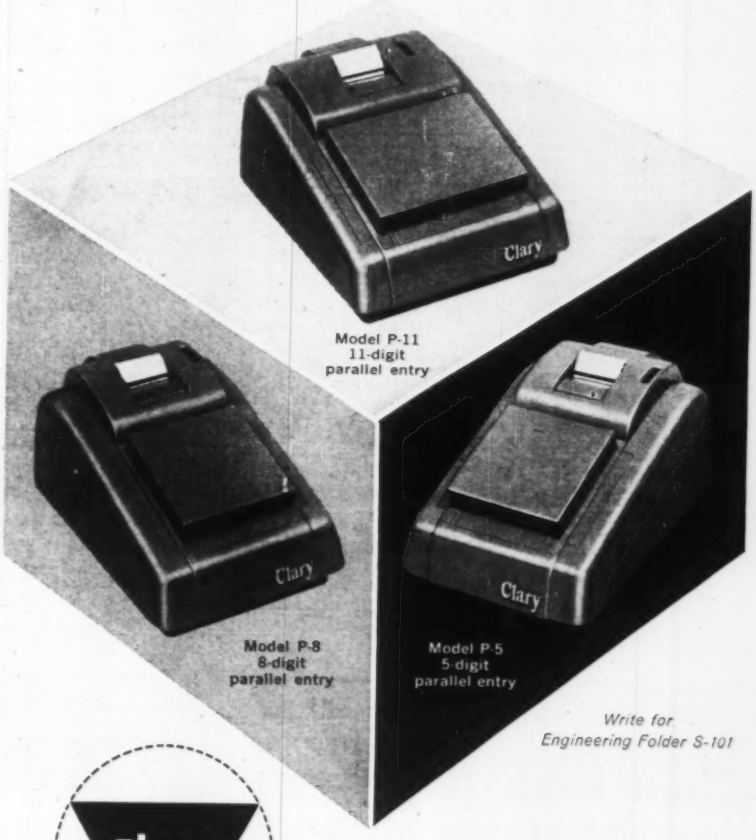
OPTICAL INSTRUMENTS. 2-page illustrated Bulletin HW-8-57 describes six optical products made by England's Hilger & Watts Ltd.—Jarrel-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Circle **444** on inquiry card.

now! 7-day delivery

on any 3 standard data printers

Now from Clary! Data printers delivered to you in a fraction of the usual time! Only Clary offers you 3 *standard* data-printing models with your choice of special dials and punctuation. Years of experience in this field have shown that these 3 standard models can be used in 85% of all data-printing applications...and at tremendous time and cost savings. Special built models are also available, if needed.



Write for Engineering Folder S-101

Clary

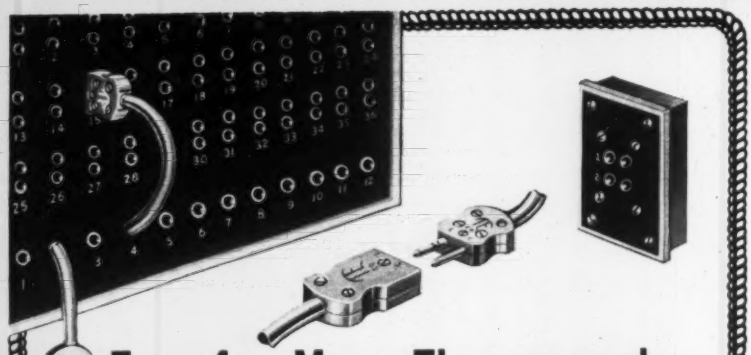
Manufacturer of Industry's most versatile data printers

ELECTRONICS DIVISION

Clary Corporation, San Gabriel, California

Manufacturer of business machines, electronic data-handling equipment, aircraft and missile components.

For more information circle **162** on inquiry card.



Transfer Many Thermocouples

With T-E Quick-Coupling Connectors and Panels

Connector Panels T-E has one for your exact needs. These panels provide flexible, centralized control in transferring any number of thermocouples to indicating, multi-point recording and controlling pyrometers. Ideal for patch panel use, they are available in many compact shapes and sizes — with interchangeable plugs and jacks in I-C, C-C, and C-A. A panel for 48 thermocouples and 16 pyrometers measures only 13¼" x 7⅞". Polarity markings and screw-fastened connections make wiring easy.

Quick-Coupling Connectors These connectors permit fast, easy making and breaking of thermocouple circuits. Durable construction guarantees long, dependable usage. Polarized and mechanically interchangeable, all plugs and jacks are of standard matched thermocouple materials. Spring-loaded contacts with long wiping surfaces provide firm but easily broken connections.

Write for Bulletin 23-F.

Thermo Electric Co. Inc.
SADDLE BROOK, NEW JERSEY
In Canada — THERMO ELECTRIC (Canada) Ltd., Brampton, Ont.

For more information circle **163** on inquiry card.

BALZERS Thin Film Optics

From the Principality of Leichtenstein Swiss Customs Area

ROLYN ARCADIA (Calif.)

Front Surface Mirrors, Cold Mirrors, Achromatic Beam Splitters, Dichroic Beam Splitters, Monochromatic Interference Filters, Wedge Interference Filters, Heat-Reflecting Interference Filters, Cut-Off Filters, Anti-Reflection Coatings, Heat Protective Coatings and many other thin layers.

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Balzers means research in high vacuum process

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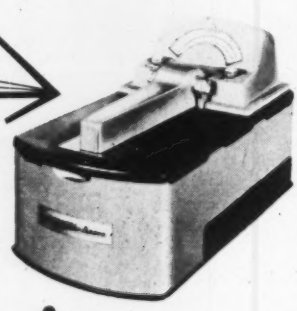


The Macbeth-Ansco Model 12A Densitometer is an extremely sensitive photometer designed to indicate optical densities, on a direct reading density scale 0-4.0, with narrow pass band filters. (Range without filters 0-6 or 7 log cycles). Precision ± .02 density units over entire range. For portability, the measuring arm can be detached for use as a light probe. Direct reading, the new Macbeth-Ansco Densitometer, can be operated in ambient room illumination. As standard electronic tubes and components are used throughout, there is no necessity for individually calibrated meter scales, pre-aged tubes, etc. The following "plug-in" accessories are available: REFLECTION DENSITY ATTACHMENT-permits the measurement of small diameter areas of opaque samples. LIQUID DENSITY ATTACHMENT—enables measuring relatively dense solutions with high spectral purity. Macbeth also manufactures AC operated PH Meters, "color-corrected" lighting, and offers a Spectro-Photometric measurement service, for standards and specification control. For further information, write Dept. IA-11 for Bulletin #144.

MACBETH INSTRUMENT CORPORATION
a subsidiary of the Macbeth Corp.
PO Box 950, Newburgh, N. Y.

For more information circle **165** on inquiry card.

NEW LITERATURE

AUDIO-VISUAL PROJECTION. 20-page booklet explains effective showing of movies, slides and slide films. Includes sections on screen size, loud speaker location, projector location, etc.—Sales Service Publications, Eastman Kodak Co., Rochester 4, N. Y.

Circle **445** on inquiry card.

PROJECTOR CHART LAYOUT. 2-page bulletin describes new instrument for making chart-gage layouts directly on viewing screw of optical projectors, —Automation Gages Inc., Rochester 4, N. Y.

Circle **446** on inquiry card.

ITV CAMERA. self-contained, Model PD-500, is described in new 4-page catalog sheet.—General Precision Laboratory Inc., 63 Bedford Rd., Pleasantville, N. Y.

Circle **447** on inquiry card.

LABORATORY, ANALYTICAL

CHROMATOGRAPHY. 24-page Brochure CFP 95715 describes new Model 154-C single-stage, and new Model 188 triple-stage vapor fractometers for gas chromatography; also Model 184 for automatic plant-steam analysis.—Perkin-Elmer Corp., Norwalk, Conn.

Circle **448** on inquiry card.

FLUID DISPENSER. 2-page bulletin describes Finger Tip Fluid Dispenser which eliminates bottle pouring of acids, etc.—Palo Laboratory Supplies, Inc., 81 Reade St., New York 7, N. Y.

Circle **449** on inquiry card.

ELECTRONIC RELAY. 2-page revised data sheet describes electronic relay designed especially for safe operation of laboratory water baths.—Arthur S. LaPine and Co., 6001 South Knox Ave., Chicago 29, Ill.

Circle **450** on inquiry card.

SPECTROPHOTOMETRY. 2-page Bulletin MPL-57 describes multiple path length cell attachments for Cary Spectrophotometer, which simplify multiple-sample measurements.—Applied Physics Corp., 362 W. Colorado St., Pasadena 1, Calif.

Circle **451** on inquiry card.

CRYSTALLOGRAPHIC INSTRUMENTS. 6-page bulletin describes S-150 and S-70 High-temperature Powder Cameras, S-25 Single-crystal goniometer, S-35 Weissenberg goniometer, g-cm Evacuable Powder Camera and 19-cm Evacuable Powder Camera, made by Unicam Instruments Ltd. in England.—Jarrell-Ash Company, 26 Farwell St., Newtonville 60, Mass.

Circle **452** on inquiry card.

RADIOGRAPHIC MATERIALS for industry are described in 16-page brochure which contains a guide chart for selection of Kodak film and lists recommended development techniques in chart form.—X-Ray Sales Div., Eastman Kodak Co., Rochester 4, N. Y.

Circle **453** on inquiry card.

DATA PROCESSING

DATA PROCESSING is discussed in 6-page Folder U841 on common-language tape-to-card/card-to-tape procedures.—Remington Rand Univac Div., Sperry-Rand Corp., 315 Fourth Ave., New York 10, N. Y.

Circle **454** on inquiry card.

DATA PROCESSING. 24-page brochure describes Type 099 Data-reducer which handles almost any type of opaque or transparent, continuous or framed record and produces punched cards or paper tape, prints lists and/or graphic plots.—Telecomputing Data Reduction Systems, 12838 Saticoy St., North Hollywood, Calif.

Circle **455** on inquiry card.

PUNCHED-CARD READERS for industrial process control are described in 5-page Specification Bulletin AR-7R.—Electronics Div., Peerless Electric Co., 1401 W. Market St., Warren, Ohio.

Circle **456** on inquiry card.

DATA LOGGING. New 4-page bulletin describes four digital-display instruments: clock, counter printing matrix, industrial printing counter and preset automatic programmer.—General Automation, 701 W. Broadway, Glendale 4, Calif.

Circle **457** on inquiry card.

ACCOUNTING COMPUTER. Fifty-page booklet U921 titled "Unmeasured Daywork Payroll on the Univac 120 with Labor Distribution Cards as a By-products," contains complete set of programming charts and describes each of 40 programming steps.—Remington Rand Univac, 315 Fourth Ave., New York 10, N. Y.

Circle **458** on inquiry card.

MAG-TAPE SYSTEM. 4-page bulletin describes Series 3000 Recordata featuring 300-kc bandwidth.—Recordata Div., American Electronics Inc., 9449 W. Jefferson Blvd., Culver City, Calif.

Circle **459** on inquiry card.

TAPE TRANSMITTER/RECEIVER. 12-page Form 1539-R describes Teledata for 5, 6, 7 or 8-channel tape transmissions.—Friden Calculating Machine Co., Inc., San Leandro, Calif.

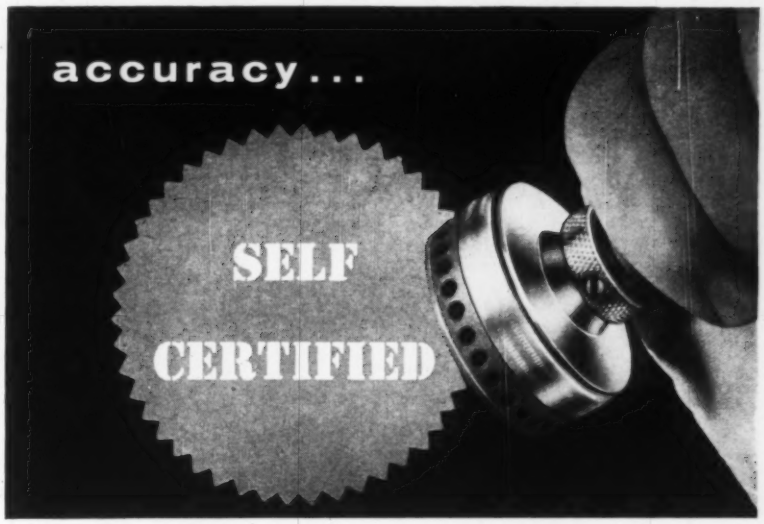
Circle **460** on inquiry card.

RECORDERS

OSCILLOGRAPHS. 4-page bulletin describes "150 Series" oscillographic recording system with one to 8 recording channels and paper speeds from 0.25 to 100 mm/sec.—Industrial Div., Sanborn Co., 175 Wyman St., Waltham 54, Mass.

Circle **461** on inquiry card.

TIME-OPERATION RECORDERS, depth-perception apparatus, reaction-time apparatus timers, and nearly thirty other such instruments are cov-



Only a manometer certifies its own measurement and provides its own verification.

Every routine manometer reading is certified . . . because it has been made by an instrument which is itself a primary standard, a universally accepted standard of reference.

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The manometer gives you a "witness test" every time you look at it.

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NOW! KAHN offers the NEW!

KAHN HEATLESS DESICCANT AIR DRYERS

Reactivated without heat

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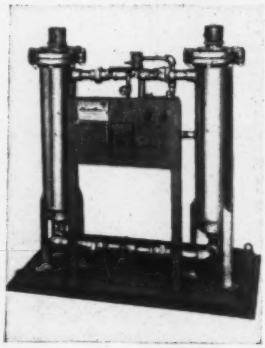

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NEW LITERATURE

ered in new 8-page catalog.—Lafayette Instrument Co., Lafayette, Ind.
Circle **462** on inquiry card.

RECORDER-CHART PAPER. Pocket-size folder contains eleven samples of Waxon papers for cold-stylus or heated-stylus recording.—Waxon-Carboff, Inc., 2 Commercial St., Rochester, N. Y.
Circle **463** on inquiry card.

OSCILLOGRAM ROLLER. 4-page bulletin introduces a device that facilitates data reduction by high-speed transport of 350-ft or 400-ft rolls of paper 3" to 12" wide.—Garth Co., P.O. Box 935, Lancaster, Calif.
Circle **464** on inquiry card.

TESTING

HARDNESS TESTERS. 4-page bulletin describes maker's four combination Hardness Testers for regular and superficial Rockwell Tests.—The Torsion Balance Co., Monhegan Ave., Clifton, N. J.
Circle **465** on inquiry card.

ELECTRONIC ANALYZER. New 4-page Bulletin IEB-24 describes "Hydraulscope," an electronic analyzer utilizing oscilloscopic principles to measure pressure activity and phenomena in the operation of hydraulic systems.—Aeroquip Corp., 300 S. East Ave., Jackson, Mich.
Circle **466** on inquiry card.

TEST GAGES. 4-page Bulletin M-28 describes new series of precision test gages with 360° graduations.—Martin-Decker Corp., Long Beach, Calif.
Circle **467** on inquiry card.

PICK-UP CALIBRATOR. Four-page brochure describes Type C calibrator for strain gages, thermocouples, etc.—Allegany Instrument Co., Inc., 1091 Wills Mountain, Cumberland, Md.
Circle **468** on inquiry card.

ELECTRICAL, ELECTRONIC INSTRUMENTS

LONG-SCALE INSTRUMENTS. Eight-page brochure describes new line of tachometers, milliammeters and thermometers with 250-degree scales for greater readability. Case sizes from miniature to 4¾".—Weston Electrical Instrument Corp., Newark 12, N. J.
Circle **469** on inquiry card.

FREQUENCY MEASUREMENT. 2-page Technical Data describes new Model 7700 Sensitive Radiated Frequency Measuring System.—Beckman/Berkeley Div., 2200 Wright Ave., Richmond, Calif.
Circle **470** on inquiry card.

PHASE ANGLE VOLTMETER. Sixteen-page booklet of "Application Notes" on Model VM-200 Series Phase Angle Voltmeters illustrates instrument's use as a phase-sensitive vector voltmeter and ac VTVM.—North Atlantic Industries, Inc., 603 Main St., Westbury, L. I., N. Y.
Circle **471** on inquiry card.

DELAY LINES, adjustable instruments, are described in 4-page Catalog DLI 1.7 which includes a table of characteristics.—Micropulse Engineering, 1122 W. Magnolia Blvd., Burbank, Calif.

Circle **472** on inquiry card.

VOLTAGE REGULATION. 28-page pocket-size booklet details a dozen case histories on the use of Regohm voltage regulators, from various fields such as electroplating, railroad controls, and airborne photography. —Electric Regulator Corp., Norwalk, Conn.

Circle **473** on inquiry card.

PULSE GENERATOR, 2-page technical bulletin describes Type 1050 High Frequency Pulse Generator.—Burroughs Corp., Electronic Instrument Div., 1209 Vine St., Phila. 7, Pa.

Circle **474** on inquiry card.

EDGEWISE INDICATOR. 2-page Data Sheet gives specifications of new Model 1135 Side Indicator Panel Meter with 2% accuracy and 2-second response time.—International Instruments Inc., P. O. Box 2954, New Haven 15, Conn.

Circle **475** on inquiry card.

GALVANOMETER. 4-page bulletin describes Hilger & Watts Ltd. galvoscale mirror galvanometer incorporating its own lamp and scale.—Jarrell-Ash Co., 26 Farwell St., Newtonville 60, Mass.

Circle **476** on inquiry card.

AMPLIFIER. 2-page Bulletin 572 describes new type 190 Differential Data Amplifier with 0.01% accuracy. —Offner Electronics Inc., 5320 N. Kedzie Ave., Chicago 25, Ill.

Circle **477** on inquiry card.

AMPLIFIER. 2-page Price List P-5703 describes Model 198 (Silicon) 90-db Transistor Amplifier.—Taber Instrument Corp., 111 Goundry St., North Tonawanda, N. Y.

Circle **478** on inquiry card.

TUBES, TRANSISTORS

SELENIUM RECTIFIER. New 2-page Bulletin GEA-6538B describes miniature selenium rectifier for TV horizontal-phase-detector diode.—General Electric Co., Schenectady 5, N. Y.

Circle **479** on inquiry card.

TRANSISTOR applications in wideband video and variety of RF and IF devices are discussed in 6-page Brochure G-120 on germanium p-n-p and n-p-n alloyed junction transistors.—General Transistor Corp. 91-27 138th Place, Jamaica 35, N. Y.

Circle **480** on inquiry card.

ELECTRON TUBES, Twelve-page new Catalog 557 describes thyratron and rectifier tubes. Includes four-page tables of data.—8-page catalog, 6-page technical article, and several loose leaves, discuss Cetron phototubes (gas-filled and vacuum) and lead sulfide photocells.—Continental Electric Co., Taylor Tubes, Inc., 6 N. Michigan Ave., Chicago 2, Ill.

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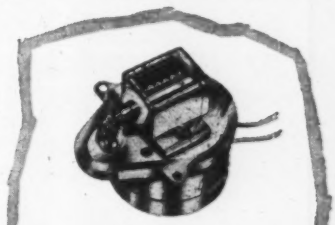

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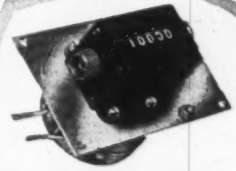

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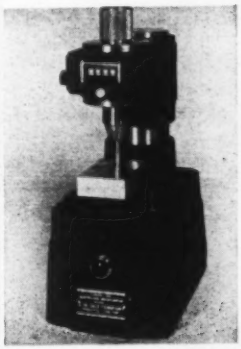

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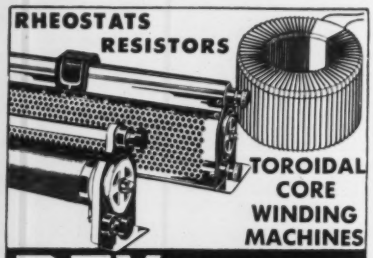

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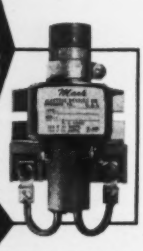

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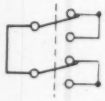
NEW LITERATURE

RELAYS, SWITCHES



RELAYS. Four-page bulletin describes new Type 4 multi-contact relays, illustrates this type's fifteen different series and tabulates characteristics.—Phillips Control Corp., 59 W. Washington St., Joliet, Ill.
Circle **482** on inquiry card.

FOOT SWITCHES. New 2-page bulletin describes Series VK Comet and Series VKD Comet-Duet for business machines, recorders, dispensers, photographic equipment, etc.—Vemaline Products Co., P. O. Box 222, Hawthorne, N. J.
Circle **483** on inquiry card.

INDICATING LIGHTS AND SWITCHES. Three Handbook spec sheets on tiny new Pan-i-Lite Switch.—Alden Products Co., Dept. TSLS-133, Brockton, Mass.
Circle **484** on inquiry card.

TRIMMING RESISTORS. Two 2-page bulletins describe wirewound Trimit and carbon Trimit respectively.—Bourns Laboratory, Inc. 6135 Magnolia Ave., Riverside, Calif.
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RESISTORS,

VOLTAGE-DIVIDING RESISTORS. New "Data File" binder contains 12-page technical paper on environmental effects; 4-page data sheet 54-75 on multi-turn potentiometers; 2-page summary data sheet 54-35; Data Sheet 54-87 on laboratory model; and Data Sheet 54-78 on turns-counting dials.—Beckman/Helipot Corp., Newport Beach, Calif.
Circle **486** on inquiry card.

RESISTORS. Fixed-composition types are described with numerous charts and graphs in new 8-page Bulletin B-1C.—Insulated wire-wound types are catalogued and specified in new 4-page Bulletin B-5C.—International Resistance Co., 401 North Broad St., Phila. 8, Pa.
Circle **487** on inquiry card.

RESISTORS, NETWORKS. New 8-page catalog covers complete line of custom-made precision wirewound, encapsulated resistors and hermetically sealed resistor networks.—General Resistance, Inc., 577 East 156th St., New York 55, N. Y.
Circle **488** on inquiry card.

FLUORESCENT BALLASTS. 2-page Bulletin MOPR-12 describes Klixon B9500 Miniature Snap-Acting Protector.—Spencer Thermostat Div., Metals & Controls Corp., Attleboro, Mass.
Circle **489** on inquiry card.

ELECTRICAL, ELECTRONIC COMPONENTS

ELECTRONIC EQUIPMENT. 16-page tabloid-style catalog lists a wide variety of relays, contacts, cams, motors, switching assemblies, steppers, amplifiers, servos, etc.—Soundtronics Labs., 630 Arch St., Phila. 6, Pa.
Circle **490** on inquiry card.

CAPACITORS. New 6-page Leaflet CQM presents complete engineering data on computer-quality electrolytic capacitors available in various capacitance and voltage combinations.—Pyramid Electric Co., 1445 Hudson Blvd., North Bergen, N. J.
Circle **491** on inquiry card.

PULSE TRANSFORMERS. New 12-page Catalog C 201 describes pulse transformers, toroids and filters.—Pulse Engineering, 2657 Spring St., Redwood City, Calif.
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ELECTRICAL COMPONENTS. 6-page brochure titled "Engineered Components and Assemblies" describes 29 types of connectors, relay bases and sockets, terminals, cable clamps, etc.—U. S. Components, Inc., 454 East 148th St., New York 55, N. Y.
Circle **493** on inquiry card.

TERMINAL BLOCKS. 4-page Catalog XLX-6 describes three new lines of terminal blocks.—Excellex Electronics Inc., 475 Chestnut St., Cedarhurst, L. I., N. Y.
Circle **494** on inquiry card.

FILM CAPACITORS. 4-page Bulletin 2053 describes Type 194P polystyrene film capacitors—Sprague Electric Co., North Adams, Mass.
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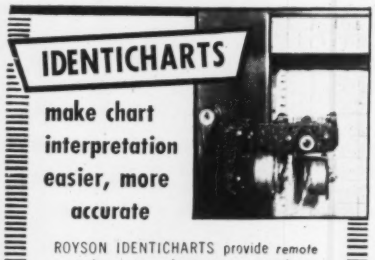

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ELECTRONIC COMPONENTS. Four 2-page new-product bulletins announce three-channel multiplexer, reciprocal Ferrite switch, microwave Ferrite single sideband modulator, and four-port Ferrite circulator.—Rantee Corp., Calabasas, Calif.

Circle **496** on inquiry card.

SUBMINIATURE INDICATOR LIGHTS. 4-page Form L-159 describes new indicator lights incorporating tiny GE Neon Glow Lamp NE-2D.—Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

Circle **497** on inquiry card.

WIRES, CONNECTORS

CONNECTORS. Forty-eight page "OK Methods Manual" promotes good assembly practices; also discusses wire preparation and soldering techniques. —Amphenol Electronics Corp., 1830 South 54th Ave., Chicago 50, Ill.

Circle **498** on inquiry card.

QUICK DISCONNECT. 2-page Preliminary Release describes new Q Series connectors.—Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif.

Circle **499** on inquiry card.

PRINTED CIRCUIT CONNECTOR. 2-page technical bulletin describes new Continental Connector printed circuit connector with right angle pins and polarizing screwlocks.—Electronic Scales Div., DeJur-Amsco Corp., 45-01 Northern Blvd., Long Island City 1, N. Y.

Circle **500** on inquiry card.

WIRE, CABLE AND CONDUIT. 6-page technical bulletin RCP100 describes characteristics of and uses for most of firm's products.—Technical Bulletin Div., Rome Cable Corp., Rome, N. Y.

Circle **501** on inquiry card.

CONNECTORS. Binder contains 24 loose-leaf pages of catalog data on new Hubbell Interlock self-locking connectors.—Avnet Interlock Sales Corp., 8966 National Blvd., Los Angeles 34, Calif.

Circle **502** on inquiry card.

MECHANICAL COMPONENTS

MINIATURE BEARINGS. New 24-page edition of 1957 Catalog of miniature ball bearings includes Type SS2C, the smallest fully-ground precision retainer ball bearing manufactured in the U.S.A.—Miniature Precision Bearings, Inc., Precision Park, Keene, New Hampshire.

Circle **503** on inquiry card.

O-RINGS. New 12-page revised Catalog 5701 covers O-ring sizes, including gland design and compound charts.—Rubber Products Div., The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

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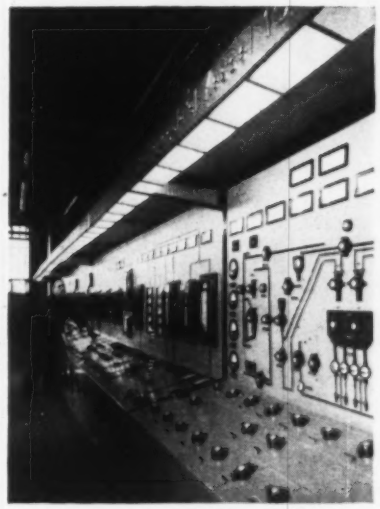

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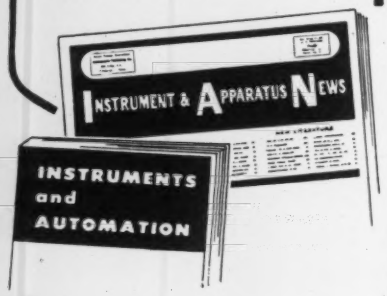

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NEW LITERATURE

INSTRUMENT BEARINGS. New 36-page catalog gives details on precision instrument ball bearings.—New Departure, Div., General Motors Corp., Bristol, Conn.

Circle **505** on inquiry card.

BALL BEARINGS. 8-page Catalog 577 covers super-precision-ground ball bearings.—Harold R. Swanton, Inc., 1706 So. Grand Ave., Los Angeles 15, Calif.

Circle **506** on inquiry card.

SCREW MACHINE PARTS. New 4-page folder describes facilities for fabricating special screw machine parts up to 2¼" dia; gives examples of cost-cutting, production speed-up and product improvement.—Merit Specialties Co., Inc., 205 E. Davis St., St. Louis 11, Mo.

Circle **507** on inquiry card.

PHOTO-FORMING of metal parts is described in 8-page Bulletin 90. Two processes—chemical etching and electrolytic etching—are employed.—Photo-Forming Dept., Superior Tube Co., Norristown, Pa.

Circle **508** on inquiry card.

ELECTRIC BRAKES and Clutches, from miniature sizes to FHP ratings, are described in 8-page Catalog WEB 6292.—Warner Electric Brake & Clutch Co., Beloit, Wis.

Circle **509** on inquiry card.

HIGH-PRECISION BALLS, 8-page Bulletin 101 gives complete information about "Micro-Velvet" balls.—Hoover Ball and Bearing Co., Ann Arbor, Mich.

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BEARING TORQUE TESTER. Six-page folder describes new automatic continuous-rotation tester for instrument ball bearings.—The Fafnir Bearing Co., New Britain, Conn.

Circle **511** on inquiry card.

MISCELLANEOUS

AUTOMATIC STARCH CONVERSION. 2-page Bulletin No. V-1221 describes system for enzyme starch conversion, which controls to correct viscosity.—Norcross Corp., 247 Newtonville Ave., Newton 58, Mass

Circle **512** on inquiry card.

XEROGRAPHY. 8-page Form X275 describes XeroX copying equipment.—The Haloid Co., Rochester 3, N. Y.

Circle **513** on inquiry card.

TESTING SERVICES is title of a new 12-page brochure on plant, equipment facilities and services offered by company.—Aerotest Labs. Inc., 129-11 18th Ave., College Point 56, N. Y.

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NEW LITERATURE

PHOTOCOPYING. New 4-page Bulletin No. 57S2 on "Speedmaster" high-production dry-process white-printers describes new 44" Model 4000C.—P&H Sales Corp., 5640 N. Western Ave., Chicago 45, Ill.

Circle **515** on inquiry card.

CHEMICAL FEEDER. 4-page Technical Publication TP-9-M describes Series A-690 volumetric-type dry feeder with either jet or mechanical-mixed solution chamber.—Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J.

Circle **516** on inquiry card.

FACILITIES. 4-page folder pictures and outlines facilities for R&D, design of equipment and systems, production engineering, and building of pilot models and short-run production. —Strand Engineering Co., 1354 N. Main St., Ann Arbor, Mich.

Circle **517** on inquiry card.

INSULATION. 4-page catalog describes ten types of Epocast thermosetting epoxy resins.—Furane Plastics Inc., 4516 Brazil St., Los Angeles 39, Calif.

Circle **518** on inquiry card.

ENGINE CONTROL. 4-page Bulletin 757 describes Model NUL "Universal" automatic controller for diesel and gasoline engines.—Alexander F. Barron, 53 West Jackson Blvd., Chicago 4, Ill.

Circle **519** on inquiry card.

SQUARING MECHANISM. 2-page bulletin describes new bidirectional device for squaring or extracting square roots.—Belock Instrument Corp., 111-01 14th Ave., College Point, N. Y.

Circle **520** on inquiry card.

PERSONNEL PROTECTION DEVICES. Pocket-size Bulletin FB describes company's complete film badge services.—Technical Publications Dept., Tracerlab, Inc., 1601 Trapelo Rd., Waltham 54, Mass.

Circle **521** on inquiry card.

OVERFILL ALARM. 4-page catalog data, and 1-page article reprint, on gas-operated Models TP and VO which give extremely loud warning. —Falcon Alarm Co., Inc., 243 Broad St., Summit, N. J.

Circle **522** on inquiry card.

TUBE PIN STRAIGHTENERS. Two 2-page bulletins and 8-page pocket Form 162 covers new line of tube pin straighteners and socket wiring plugs.—Star Expansion Products Div., 142 Liberty St., New York 6, N. Y.

Circle **523** on inquiry card.

ELECTRONIC & CRT EQUIPMENT is described in new 2-page Short form Catalog 3547.—Industrial Test Equipment Co., 55 East 11th St., New York 3, N. Y.

Circle **524** on inquiry card.

SINGLE-TERMINAL FEED-THROUGHS and stand-offs are described and illustrated in maker's new 12-page catalog 657-B.—Hermetic Seal Corp., Dept. IA, 29 S. 6th St., Newark 7, N. J.

Circle **525** on inquiry card.

BATTERY HOLDERS. 4-page brochure covers spring clip battery holders.—Austin Craft Co., 431 South Victory Blvd., Burbank, Calif.

Circle **526** on inquiry card.

TAPE WINDER, that will feed accumulated rolls of common language tape to any input from the original starting point without rewind in any direction is described in new 4-page brochure.—Whiteford Lab., 420 Market St., San Francisco, Calif.

Circle **527** on inquiry card.

RECTIFIER TUBES and thyratons are described and illustrated in new 12-page Form 557. Phototubes and lead sulfide photoconductive cells are covered in new 8-page Form No. 257.—Continental Electric Co., 6 North Michigan Ave., Chicago 2, Ill.

Circle **528** on inquiry card.

HIGH-VACUUM EQUIPMENT for Laboratory and industrial applications is described in new 24-page Bulletin 1-1.—Consolidated Electrodynamics Corp., Rochester Div., 1775 Mt. Read Blvd., Rochester, N. Y.

Circle **529** on inquiry card.

MOISTURE and basis weight control. Use of "Betameter" for primary measurement of basis weight and of "aquatel" for moisture determination, is described in new 8-page Bulletin No. 19.—Isotope Products, Buffalo, N. Y.

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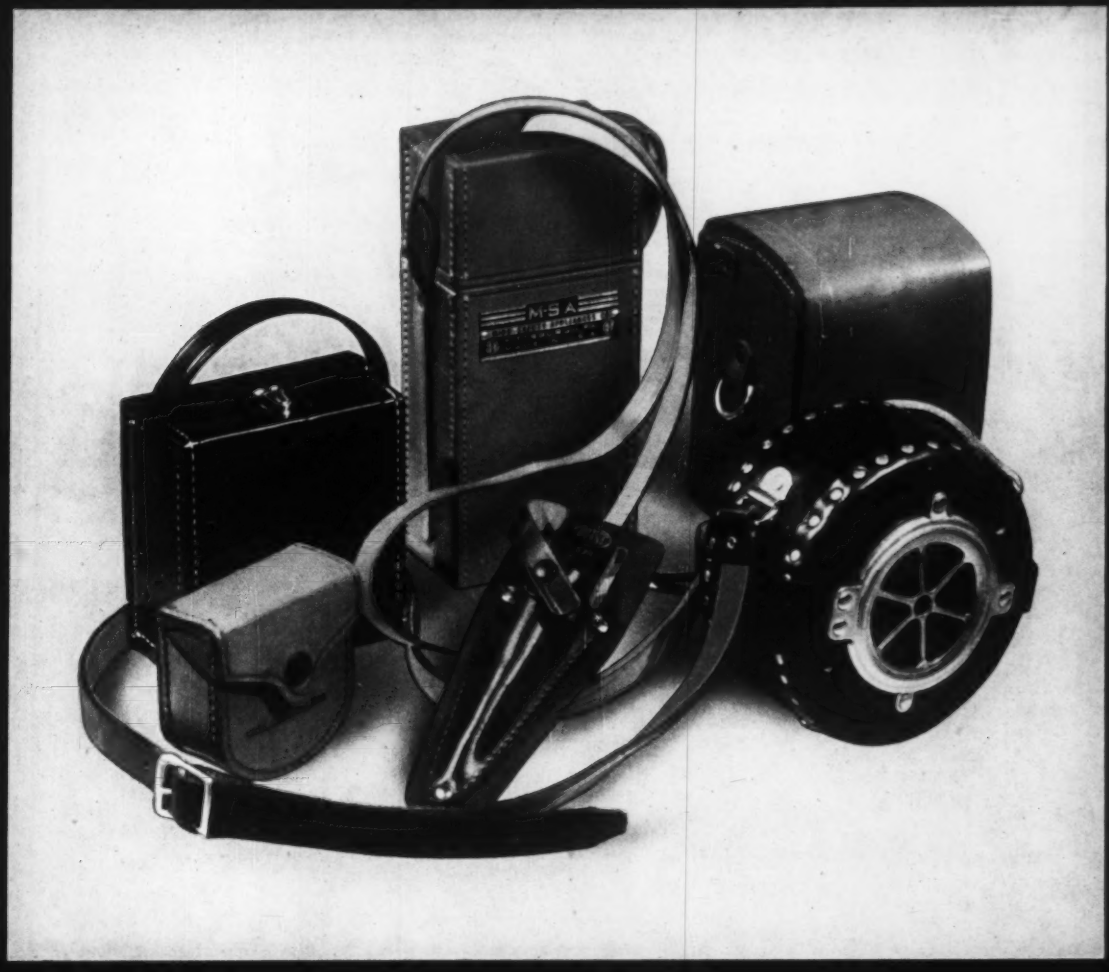

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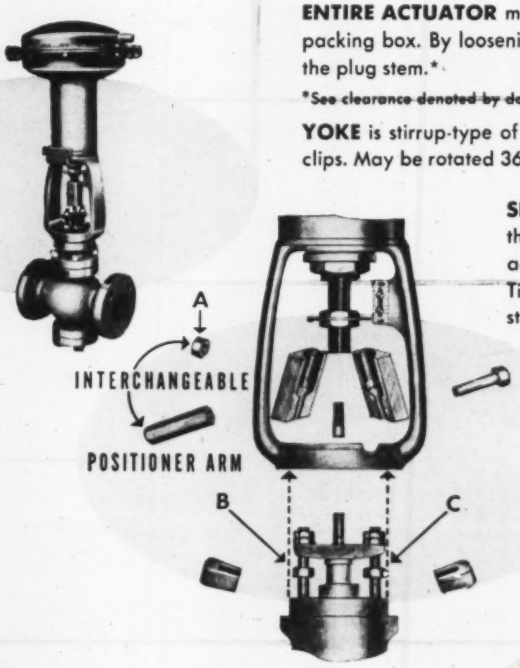

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*See clearance denoted by dotted lines and arrows.

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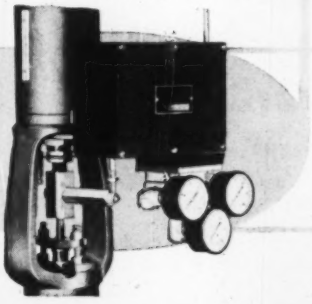

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